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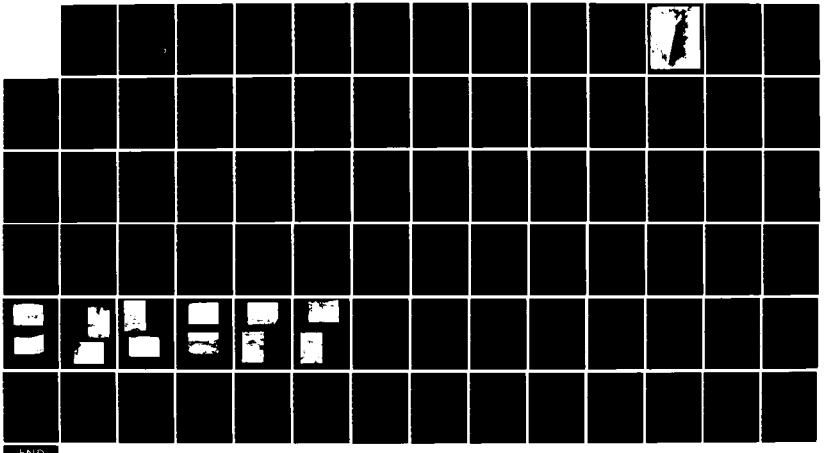

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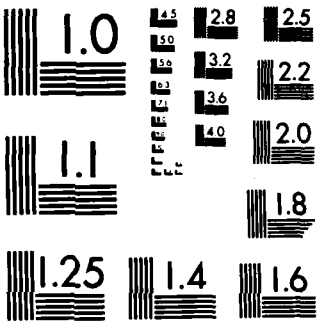
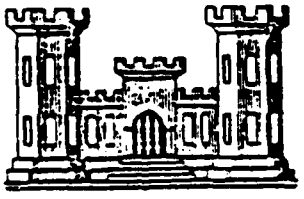


CONNECTICUT RIVER BASIN
CONWAY, MASSACHUSETTS

ROARING BROOK DAM
MA 01056

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

AUGUST 1981

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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4. TITLE (and Subtitle) Poaring Brook Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
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Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Connecticut River Basin
Conway, Massachusetts
Roaring Brook

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a 65 ft. high, 435 ft. long earth embankment dam with an ungated spillway contianing provisions for 24 inch flashboards and a manually operated 18 inch main drain. Based on the visual inspection the dam seems to be in good condition. However, due to the lack of an accessible upstream control for the drain, the dam is considered in fair condition. It is intermediate in size with a hazard classification of high.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:
NEDED

SEP 24 1981

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Roaring Brook Dam (MA-01056) Phase I Inspection Report, prepared under the National Program for Inspection of Non-Federal Dams. This report is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. I approve the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is vitally important.

Copies of this report have been forwarded to the Department of Environmental Quality Engineering, and to the owner, South Deerfield Water Supply District. Copies will be available to the public in thirty days.

I wish to thank you and the Department of Environmental Quality Engineering for your cooperation in this program.

Sincerely,

C. E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
BRIEF ASSESSMENT

IDENFIFICATION:	MA 01056
NAME OF DAM:	Roaring Brook Dam
TOWN:	Conway
COUNTY AND STATE:	Essex, Massachusetts
STREAM:	Roaring Brook
DATE OF INSPECTION:	July 8, 1981

The dam is a 65 foot high, 435 foot long earth embankment dam with an ungated spillway containing provisions for 24 inch flashboards and a manually operated 18 inch main drain. Construction of the dam was completed in 1973. The dam is owned and operated by the South Deerfield Water Supply District.

Seepage was observed at two locations at toe of the dam. However, based on field observations, review of design drawings and discussion with the dam operator, the observed seepage is not likely to cause internal erosion and instability of the dam. The upstream controls for the drain are underwater and not readily accessible. Based on the visual inspection the dam appears to be in good condition. However, due to the lack of an accessible upstream control for the drain, the dam is considered in fair condition.

The dam has a size classification of intermediate and a high hazard potential. Based upon Corps Guidelines, the test flood would be the full PMF. The test flood inflow would be 8,400 cfs, from the 4 square mile drainage area. The routed test flood discharge is 8025 cfs without flashboards and 8075 cfs with flashboards. The corresponding surcharge elevations would be 546.4 and 547 respectively. The top of dam, elevation 546, would be overtopped in both cases by 0.4

and 1.0 feet, respectively. The spillway area can pass 86± percent and 97± percent of the routed test flood outflow, with and without flashboards, respectively.

It is recommended that the Owner engage a qualified registered professional engineer to: design and implement the construction of a weir to monitor seepage and a service bridge to provide upstream access to the controls for the drain; evaluate the stability of the downstream slope of the dam under all design conditions.

The Owner should institute remedial measures which include: cutting of brush growth on the crest and downstream slope; cutting of trees at the junction of the spillway discharge channel and outlet discharge channel; develope a formal downstream warning system and institute a program of annual technical inspection.

The recommendations and remedial measures should be implemented by the Owner within one year after receipt of this Phase I Inspection Report.

Ronald H. Cheney

Ronald H. Cheney, P.E.
Vice President

Hayden, Harding & Buchanan, Inc.
Boston, Massachusetts

This Phase I Inspection Report on **Roaring Brook Dam (MA-01056)** has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

JOSEPH W. FINEGAN, JR., CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the

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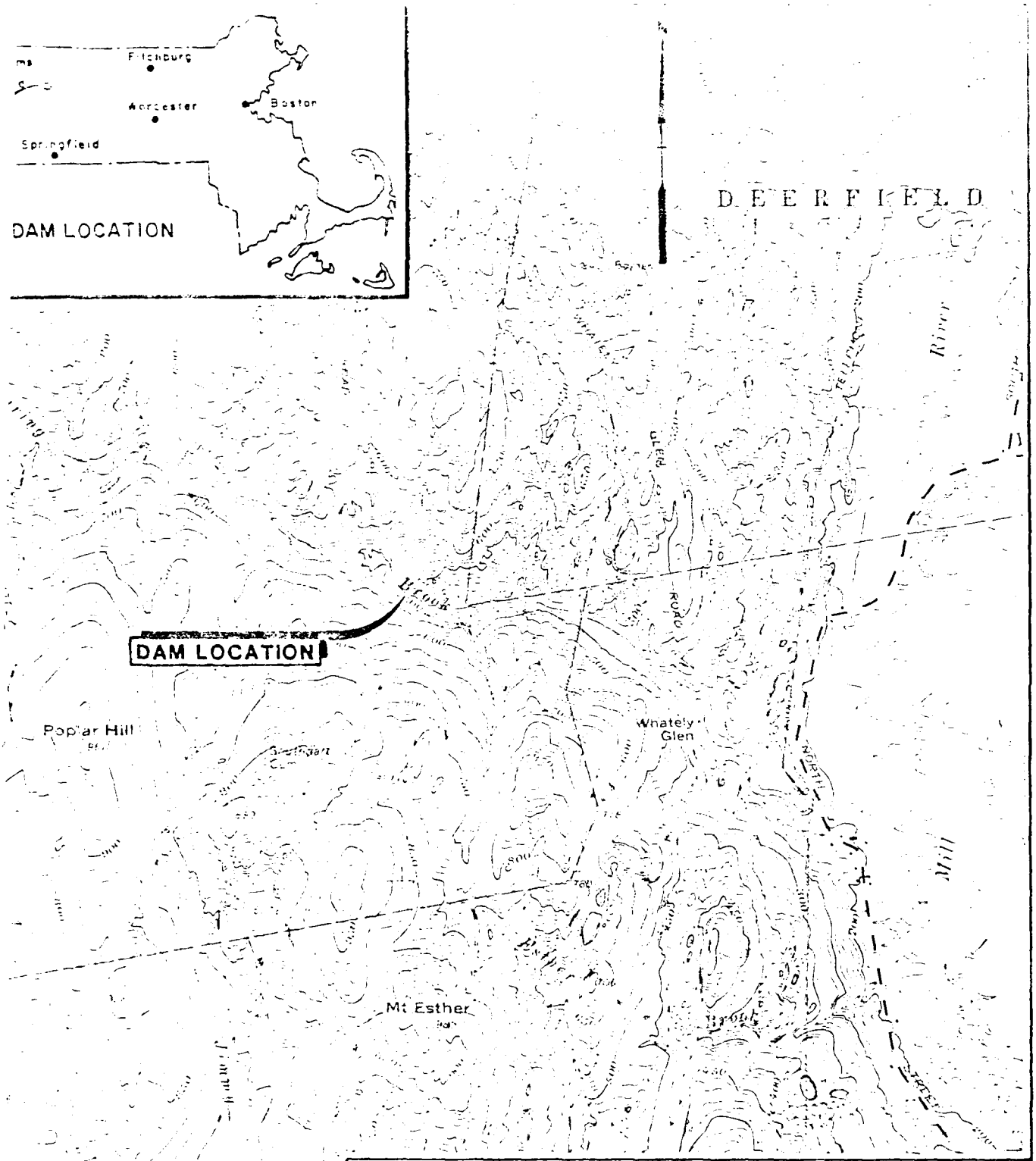


HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

ROARING BROOK DAM
LOCATION PLAN

CONWAY MASSACHUSETTS

			SCALE 1:24000
			DATE AUGUST, 981

PHASE I
NATIONAL DAM INSPECTION PROGRAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Hayden, Harding & Buchanan, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Hayden, Harding & Buchanan, Inc. on 26 June 1981 by William E. Hodgson Jr., Colonel, Corps of Engineers. Contract No. DACW 33-80-C-0006 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly, effective dam safety programs for non-Federal dams.

observations, review of the design drawings and discussion with the dam operator, the observed seepage is not likely to cause internal erosion and instability of the dam.

The drain can only be controlled from the downstream toe. This pipe is always under pressure.

The downstream slope of the dam is relatively steep, 1.5H:1V, and review of the stability of the slope should be performed.

Based on the visual inspection, the dam appears to be in good condition. However, due to the lack of an accessible upstream control for the drain, the dam is considered in fair condition.

The spillway discharge channel runs from the left abutment to where it joins the outlet discharge channel about 100 feet downstream of the outlet pipe. Several trees are growing at the junction of these discharge channels photograph 11.

The spillway weir was observed to be in good conditon.

2. Outlet

The gates at the outlet structure shown in photograph 8 are operated frequently and appear to be in good condition. The controls at the inlet are underwater and not readily accessible.

The outlet discharge channel is in good condition and free of obstructions.

d. Reservoir Area

There are no indications of instability along the banks of the reservoir in the vicinity of the dam.

e. Discharge Channel

Both the spillway discharge channel and outlet discharge channel are in good condition except for the trees growing at the intersection of these channels.

3.2 Evaluation

Some seepage was observed at two locations at the toe of the dam. Based on discussions with representatives of the South Deerfield Water Supply District, this seepage could be the result of springs located in the abutments. Based on field

3. Downstream Slope

The downstream slope, shown in photograph 1 is constructed with four 4-foot-wide berms at intermediate levels. The slope is fully covered with riprap and is constructed at a slope of 1.5H:1V.

Occasional tall brush is growing on the slope. The lowest section of the downstream slope curves slightly downstream between abutments. It appears that the slope was constructed this way and no sign of settlement or other movement is evident.

Seepage on the order of 2 gallons per minute was flowing from an area on the right side of the outlet pipe (looking downstream). This seepage is shown in photograph 10 and appears clear and no evidence of soil erosion is present. On a subsequent visit to the dam on July 31, 1981, a second area of seepage on the left side of the outlet pipe was observed with a flow rate on the order of 1 gpm. This seepage, shown in photograph 12, was also very clear.

c. Appurtenant Structures

1. Spillway

The spillway channel is cut out of bedrock in the left abutment as shown in photograph 4. The walls and channel floor are in good condition with no significant loose rock or debris.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General

The dam was inspected on July 8, 1981. At the time of the inspection there was 24 inches of flashboard in place at the spillway weir. The level of the reservoir was at the top of flashboards, elevation 540.0.

b. Dam

The dam is a zoned earth embankment about 65 feet high, 435 feet long, and 25 feet wide at the crest.

The design drawings indicate that the dam is founded on bedrock and contains a "semi-pervious" upstream and downstream shell, an "impervious core," and transition zones. A rolled rock zone forms the lower one-third of the downstream shell. Both slopes are fully protected with dumped riprap.

A spillway is cut into the rock on the left abutment.

1. Upstream Slope

The upstream face of the dam has a slope of 2.5H:1V and is shown in photograph 5. The riprap above the reservoir level is in good condition.

2. Crest

The dam crest shown in photograph 6 shows no indication of misalignment or subsidence. The crest has a poor turf cover over most of its width and has tall brush on both the upstream and downstream edges.

The limited amount of hydraulic/hydrologic data provided did not allow an indepth review of the original design.

c. Validity

The visual inspection of this facility showed no reason to question the validity of the design plans with the exception of the spillway length. The spillway was originally designed having a 60 foot length, but changed during construction to an 80± foot length.

SECTION 2

ENGINEERING DATA

2.1 Design Data

The dam was designed in 1972 by Tighe and Bond Consultants, Easthampton, Massachusetts. Design plans were provided by the Owner. Limited hydraulic/hydrologic design data was provided by Tighe and Bond.

2.2 Construction Data

The dam was built during 1973 to 1974. No construction data was located for this dam.

2.3 Operation Data

No operational manual for the dam was located.

2.4 Evaluation of Data

a. Availability

Design plans were provided by the Owner. Limited hydraulic/hydrologic data was provided by the designer Tighe and Bond. No inspection reports were located at the State Department of Environmental Quality Engineering.

b. Adequacy

The information available was adequate to perform a Phase I level investigation of the dam.

(4) Top Width ---------- 25'

(5) Side Slopes (downstream) ---------- 1.5H:1V
(upstream) ---------- 2.5H:1V

(6) Zoning ---------- as shown on B-5

(7) Impervious core ---------- as shown on B-5

(8) Cutoff ---------- as shown on B-5

(9) Grout curtain ---------- None shown

h. Diversion and Regulating Tunnel - None at this project

i. Spillway

(1) Type ---------- broadcrested weir

(2) Length of weir ---------- 80± feet

(3) Crest elevation (without flashboards)- 538
(with flashboards) --- 540

(4) Gates ---------- None

(5) U/S Channel - None ------- opens directly to lake

(6) D/S Channel ---------- bedrock

j. Regulating Outlets

The regulating outlet at the dam is the 18 inch drain. The drain has an 18 inch and a 12 inch shutoff valve at the two inlet locations, which are at elevations 498± and 486±, respectively. The valves at the inlets are underwater and not readily accessible. They were designed to be operated by a diver.

At the outlet, there are two control valves, an 18 inch gate valve and an 18 inch butterfly valve, both at elevation 481±. The gate valve is normally kept fully open and the butterfly valve is used to regulate discharge according to water supply needs.

(7) Design surcharge (original design by Tighe and Bond for 60' long crest and 1000 year storm outflow of 2065 cfs) ---------- 546

(8) Top of dam ---------- 546

(9) Test flood surcharge - with 2' of flashbords 547
- without flashboards 546.4

d. Reservoir (Length in feet)

(1) Water supply ---------- 800

(2) Flood control pool ---------- N/A

(3) Spillway crest pool ---------- 800

(4) Top of dam ---------- 800

(5) Test flood pool ---------- 800

e. Storage (acre feet)

(1) Spillway crest pool (elevation 538) -- 387

(2) Water supply (elevation 540) --------- 423

(3) Top of dam (elevation 546) ---------- 553

(4) Test flood pool (No flashboards elev. 546.4) 561
(With flashboards elev. 547) 578

(5) Flood control pool ---------- N/A

f. Reservoir Surface (acres)

(1) Spillway crest ---------- 18.2

(2) Water supply pool ---------- 18.2

(3) Top of dam ---------- 25.2

(4) Test flood pool ---------- 27

(5) Flood control pool ---------- N/A

g. Dam

(1) Type ---------- gravity, earth, rock

(2) Length ---------- 435'

(3) Height ---------- 65'

5. Gated Spillway Capacity at Normal Pool Elevation

Not applicable.

6. Gated Spillway Capacity at Test Flood Elevation

Not applicable.

7. Total Spillway Capacity at Test Flood Elevation

The total spillway capacity with the reservoir level at the test flood elevation 546.4 and no flashboards in place is 7835± cfs. With flashboards, the capacity is 6925± cfs at elevation 547.0.

8. Total Project Discharge at Top of Dam

The total project discharge with the reservoir level at top of dam, elevation 546, and the 18 inch drain open would be 5400± cfs and 7100 cfs with and without flashboards in place, respectively.

9. Total Project Discharge at Test Flood Elevation

The total project discharge with the reservoir level at test flood elevation 546.4, no flashboards in place and the 18 inch drain open would be 8075± cfs. With flashboards, the discharge is 8120± cfs at elevation 547.0.

c. Elevation(feet above NGVD, elevations are approximate)

(1)	Streambed at toe of dam	481
(2)	Bottom of cutoff	varies
(3)	Maximum tailwater	Unknown
(4)	Water supply	540
(5)	Full flood control pool	N/A
(6)	Spillway crest (ungated)	538

The spillway has a 80± foot long, concrete weir located on the left side of the dam. It has provisions for 24 inches of flashboard. The elevation of the spillway crest with no flashboards in place is 538. The spillway channel was excavated into bedrock. It converges with the drain outlet channel (Roaring Brook) approximately 100 feet downstream of the toe of the dam.

2. Maximum Known Flood At Dam Site

There are no records of the maximum flood at the dam. The United States Weather Bureau records indicate that about 8 to 10 inches of rainfall occurred near the general location of the dam between August 17 to 20, 1955.

3. Ungated Spillway Capacity at Top of Dam

The spillway has a capacity of 7060± cfs with the reservoir water level at the top of dam, elevation 546 and no flashboards in place.

The spillway has a capacity of 5360 cfs with 2 feet of flashboards in place (normal pool elevation 540) and the reservoir water level at top of dam.

4. Ungated Spillway Capacity at Test Flood Elevation

The spillway area has a capacity of 7835± cfs with the reservoir water level at the test flood elevation of 546.4 and no flashboards in place

The spillway has a capacity of 6925± cfs with 2 feet of flashboards in place (normal pool elevation 540) and the reservoir water level at the test food elevation, 547.0.

There are normally 24 inches of flashboard in place at the spillway crest during the spring and summer. Flashboards are removed in the fall.

1.3 Pertenant Data

a. Drainage Area

The 4 s.m. (2500acre) drainage area is undeveloped rolling/mountainous land. The drainage area is within the Town of Conway and includes a portion of Conway State Forest. The main water courses within the area are Roaring Brook and Norton Hollow Brook which converge about 3/4 miles upstream from the dam. Roaring Brook discharges into the Mill River about two miles downstream of the dam.

Several secondary and unimproved roads cut across the area. The only development located within the drainage area is Roaring Brook Camp (summer camp).

b. Discharge at Dam Site

1. Outlet Works

The only two outlets at the dam are the spillway and the 18 inch drain. The 18 inch drain is manually controlled by 2 gate valves at the downstream toe. There are two control valves on the upstream intake, however, they are underwater. The 18 inch drain outlets at about invert elevation 483 and has a capacity of 40± cfs at top of dam. It discharges into Roaring Brook.

f. Operator

The dam is maintained and operated by the South Deerfield Water Supply District. Mr. John Szymanski is the Superintendent. The address is Box 51, South Deerfield, Massachusetts 01373. The telephone number is (413) 665-3540.

g. Purpose of Dam

The purpose of the dam is water supply. The dam's major function is to provide back-up capacity for the downstream South Deerfield Water Supply Dam (MA 00522) which discharges directly into the South Deerfield water supply system.

h. Design and Construction History

The dam was designed by the consulting firm of Tighe & Bond, Holyoke, Massachusetts in 1972. Construction of the dam was completed in 1975. Roy M. Wright, Inc. was the contractor.

i. Normal Operational Procedure

The dam provides storage capacity for the South Deerfield Water Supply District. The South Deerfield Water Supply Dam located approximately 4,000 feet downstream, discharges directly into the town's water supply. The level of water at the downstream dam is checked about every day and Roaring Brook Dam's water level is checked approximately every other day. The water level of Roaring Brook Dam is regulated by the drain outlet at the downstream toe, depending on the level of the downstream dam. The drain outlet is normally kept partially open throughout the year.

There is an intake structure with a high level 18 inch and low level 12 inch shutoff valve located approximately 125 feet upstream from the crest. However, there is no service bridge for this structure. The valves are underwater and must be operated by a diver. The 18 inch drain travels under the embankment and outlets at the downstream toe. There are two 18 inch control gates located at the outlet. See photograph 8 and Section B-5.

c. Size Classification

The dam is classified as intermediate based on its height of 65 feet. Corps Guideline requirements for an intermediate classification are a height of 40 to 100 feet and/or a storage capacity of 1,000 to 50,000 acre-feet. The dam has a storage capacity of 553 acre-feet.

d. Hazard Classification

The dam has a high hazard potential due to the potential loss of more than a few lives from an assumed dam failure. During dry weather conditons (no prior spillway discharge flooding), it is estimated that five homes will receive 4 to 7 feet of flood water damage from dam failure.

e. Ownership

The dam is owned by the South Deerfield Water Supply District, Board of Water Commissioners. It has always been part of their water supply system.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location

Roaring Brook Dam is located in the Town of Conway, in Franklin County, Massachusetts. The dam impounds the waters of Roaring Brook which flows east about two miles into the Mill River. The dam is shown on the Williamsburg, Massachusetts U.S.G.S. Quadrangle, having the approximate coordinates of North 42° 28' 06", West 72° 39' 48".

b. Description of Dam and Appurtenances

Roaring Brook Dam is a 65 foot high, 435 foot long earth embankment structure with an 80± foot long spillway and an 18 inch drain line. See plans in Appendix B.

The earth embankment is zoned. The zoning consists of an impervious core, a bank run gravel transition, semi-pervious zones and rolled and dumped rock. See typical Section B-5 in Appendix B. The embankment has a 25 foot wide turf covered crest and a dumped rock upstream slope inclined at 2.5H:1V. The downstream slope in rock covered, inclined at 1.5H:1V and contains a 4 foot wide berm every 12 vertical feet.

The spillway contains a concrete weir having provisions for 24 inches of flashboards. The elevation of the top of the spillway weir with no flashboards in place is 538. The spillway outlet channel was excavated to bedrock.

SECTION 4

OPERATIONAL AND MAINTENANCE PROCEDURE

4.1 Operational Procedures

a. General

The purpose of the dam is water supply. The dam provides storage capacity for the South Deerfield Water Supply District. Flashboards are used at the spillway to control the water surface elevation. Typically, 24 inches of flashboard are in place during the spring and summer. Flashboards are removed in the fall and winter. The gates at the outlet structure are normally regulated by the caretaker based on the water level of the downstream water supply reservoir (Deerfield Water Supply Dam - MA 00522).

b. Description of Warning System in Effect

There are no warning systems at this dam.

4.2 Maintenance Procedures

a. General

The dam is maintained by the South Deerfield Water Supply District. Normal maintenance includes cutting brush on the crest of the dam.

b. Operating Facilities

There is no formal operational procedure for this facility. The gates, at the downstream toe of dam, are regulated on a regular basis. Any problems within the system could be recognized fairly rapidly during normal operation.

4.3 Evaluation

There is no formal operational or maintenance procedure. Most of the year, the dam is visited about every other day by the caretaker. The Owner should institute a program of annual technical inspection and develop a formal warning system for downstream areas in case of emergency.

SECTION 5

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

Roaring Brook Reservoir is located in the southeast corner of the Town of Conway, about 800 feet west of the Conway-Deerfield town line. The drainage area, 4 s.m. (2560 acres), is wooded, undeveloped land. The terrain is rolling/mountainous. There are two main brooks, (Roaring and Norton Hollow), which have long, narrow channels.

The reservoir outlet is Roaring Brook. It flows easterly about two miles to enter the Mill River, in the Town of Whately.

5.2 Design Data

The dam was built during 1973 to 1974. Design plans dated 1972 were found. Limited hydraulic/hydrologic data was located.

5.3 Experience Data

United Stated Weather Bureau records indicate that between August 17 to 20, 1955 about 8 to 10 inches of rainfall occurred in the general area of the dam.

5.4 Test Flood Analysis

The dam has a size classification of intermediate and a high hazard potential. Based upon Corps Guidelines, the test flood would be the full PMF. The test flood inflow from the 4.0 s.m. drainage area would be 8,400 cfs based upon Corps Guide-

lines for runoff of 2100 cfs/s.m. The inflow was routed through the reservoir under the two conditions of assuming no flashboards were in place and assuming the 2 foot high flashboards were inplace. The initial water level in each case was assumed to be at either the spillway crest level, elevation 538, or at the top of flashboard level, elevation 540, prior to test flood inflow.

Without the flashboards, the routed test flood outflow is 8025± cfs at elevation 546.4. The dam is overtopped by 0.4± feet. The spillway area can pass 7835± cfs or 97± percent of the outflow.

With 2 feet of flashboards in place, the routed outflow is 8075± cfs, at elevation 547±. The dam is overtopped by 1± foot. The spillway area can pass 6925± cfs or 86± percent of the outflow.

5.5 Dam Failure Analysis

The dam was determined to have a high hazard potential due to a potential loss of more than a few lives from an assumed dam failure. The dam was assumed to have failed (dry weather condition) with the water level at elevation 540, top of spillway flashboards. A peak failure discharge of 50,300 cfs was developed by assuming a failure width of 66 feet and a water depth of 59 feet. This outflow, was routed downstream for about 7000 feet to the impact area at North Street. Prior to reaching North Street, there is no development along the outlet brook

except for the South Deerfield Water Supply Dam (MA 00522) located about 4,000'downstream. This dam would be overtopped and could possibly fail releasing 32 acre-feet of stored water.

Prior to dam failure flooding, there is no spillway discharge flooding condition. Dam failure flood stage would be about 11 feet deep at the brook. This would cause flood damage at five homes of four to seven feet deep, above first floor levels.

Beyond North Street the Brook flows to the Mill River, across undeveloped farmland. Here, there are several barns which could receive flood damage.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual inspection indicates that seepage is occurring at two locations at the toe of the dam. Based on field observations, review of the design drawings and discussion with the dam operator, the observed seepage is not likely to cause internal erosion and instability of the dam. The downstream slope of the dam is relatively steep, 1.5H:1V, and review of the stability of the slope should be performed.

6.2 Design and Construction Data

Design drawings prepared by Tighe and Bond Consulting Engineers dated November 1972 were reviewed. The following geotechnical information was obtained from these drawings:

a. The dam is a zoned earth embankment containing "semi-pervious" upstream and downstream shells, an "impervious" core, trainsition zones and a rolled rock zone at the bottom of the downstream shell. Both faces of the dam are fully protected with dumped rock overlying a transition layer.

b. The dam is founded on bedrock with a 3 foot deep keyway along the centerline of the dam.

c. The outlet pipe is equipped with concrete anti-seepage collars spaced every 25 feet along the pipe.

Based on the design of the dam, it is probable that the seepage appearing at the toe of the dam is well filtered and at the present rate of flow is not likely to cause internal erosion of the dam.

6.3 Post Construction Changes

No significant post construction changes to the dam are known.

6.4 Seismic Stability

The dam is located within Seismic Zone 2 and in accordance with the recommended Phase I guidelines does not require seismic stability analysis.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual inspection indicates that seepage is occurring at two locations at the toe of the dam. Based on field observations, review of the design drawings and discussion with the dam operator, the observed seepage is not likely to cause internal erosion and instability of the dam. The downstream slope of the dam is relatively steep, 1.5H:1V, and review of the stability of the slope should be performed.

6.2 Design and Construction Data

Design drawings prepared by Tighe and Bond Consulting Engineers dated November 1972 were reviewed. The following geotechnical information was obtained from these drawings:

a. The dam is a zoned earth embankment containing "semi-pervious" upstream and downstream shells, an "impervious" core, trainsition zones and a rolled rock zone at the bottom of the downstream shell. Both faces of the dam are fully protected with dumped rock overlying a transition layer.

b. The dam is founded on bedrock with a 3 foot deep keyway along the centerline of the dam.

c. The outlet pipe is equipped with concrete anti-seepage collars spaced every 25 feet along the pipe.

Based on the design of the dam, it is probable that the seepage appearing at the toe of the dam is well filtered and at the present rate of flow is not likely to cause internal erosion of the dam.

6.3 Post Construction Changes

No significant post construction changes to the dam are known.

6.4 Seismic Stability

The dam is located within Seismic Zone 2 and in accordance with the recommended Phase I guidelines does not require seismic stability analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

Based on the visual inspection and the design drawings, the dam is judged to be in good condition. However, due to the lack of an accessible upstream control for the drain, the dam is considered to be in fair conditon.

b. Adequacy of Information

The information available, together with the visual inspection, is adequate for a Phase I level investigation.

c. Urgency

The recommendations and remedial measures should be implemented within one year after receipt of this Phase I Inspection Report by the Owner.

7.2 Recommendations

The Owner should engage a qualified registered professional engineer to:

a. Design and implement the construction of a weir to collect and monitor the flow of seepage through the dam. The seepage flow rate should be recorded and compared to the reservoir levels and/or rain run-off levels to determine the possible source of the flow and if any remedial measures are necessary.

b. Design and implement the construction of a service bridge and necessary facilities to provide immediate upstream access to the controls for the drain.

c. Evaluate the stability of the downstream slope of dam for all design conditions.

The Owner should implement all the recommendations of the Engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures

1. Brush growth on the crest of the dam and the downstream slope should be cut as part of annual routine maintenance.
2. The trees located at the junction of the spillway discharge channel and the outlet discharge channel should be cut.
3. The Owner should develop a formal warning system for downstream areas in case of emergency.
4. The Owner should institute a program of annual technical inspection.

7.4 Alternatives

There are no practical alternatives for these recommendations and remedial measures.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT ROARING BROOK DAM

DATE July 8, 1981*

TIME 10:30

WEATHER 90's; sunny

W.S. ELEV. 540 U.S. ____ DN.S.

PARTY:

1. Ron Cheney - HHB
2. Dave Vine - HHB
3. Mike Angieri - HHB
4. Karl Dalenberg - GEI
5. John Szymanski - S.D.W.S.D
6. ____
7. ____
8. ____
9. ____
10. ____

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Embankment	R.C., D.V., M.A., K.D.	
2.	Spillway	R.C., D.V., M.A., K.D.	
3.	Outlet Works	R.C., D.V., M.A., K.D.	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

* Subsequent inspection by D. LaGatta and K. Dalenberg of GEI on July 31, 1981.

PERIODIC INSPECTION CHECKLIST

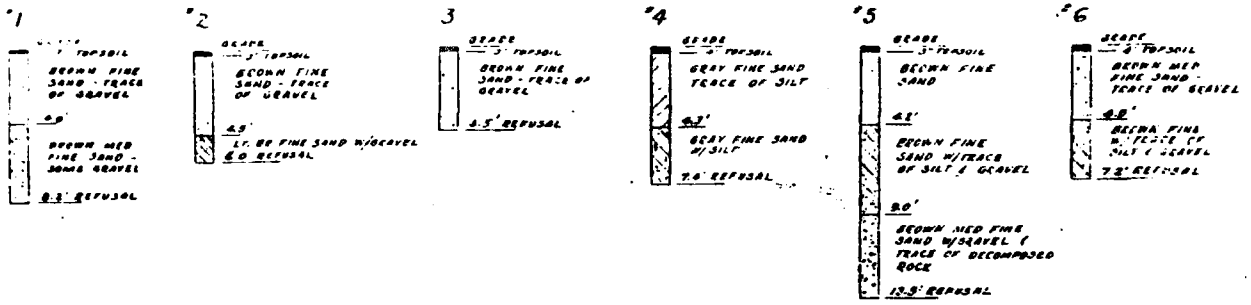
PROJECT ROARING BROOK DAM DATE July 8, 1981

PROJECT FEATURE Dam Embankment NAME K. Dalenberg, D. Vine

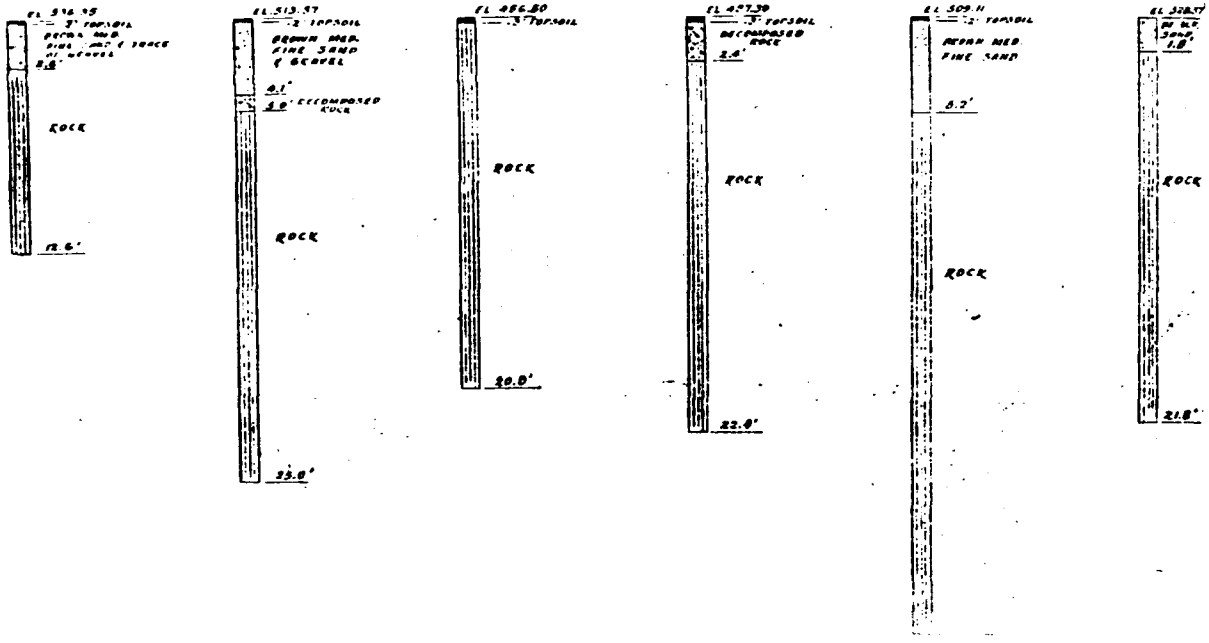
DISCIPLINE Geotechnical, Structural, Hydraulic NAME R. Cheney, M. Angieri

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	546
Current Pool Elevation	540±
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed.
Pavement Condition	No pavement.
Movement or Settlement of Crest	None observed.
Lateral Movement	None observed.
Vertical Alignment	Good.
Horizontal Alignment	Good.
Condition at Abutment and at Concrete Structures	Good.
Indications of Movement of Structural Items on Slopes	No structures on slopes.
Trespassing on Slopes	None.
Sloughing or Erosion of Slopes or Abutments	None observed.
Rock Slope Protection - Riprap Failures	Good condition - no failures.
Unusual Movement or Cracking at or Near Toe	Slope bows outward above outlet structure. Appears to have been constructed that way.
Unusual Embankment or Downstream Seepage	About 2 gpm of clear seepage on right side of outlet pipe at toe.
Piping or Boils	None observed.
Foundation Drainage Features	
Toe Drains	Rock toe.
Instrumentation System	None observed.
Vegetation	Some brush on crest and downstream slope.

BORINGS AT PROPOSED BORROW AREAS



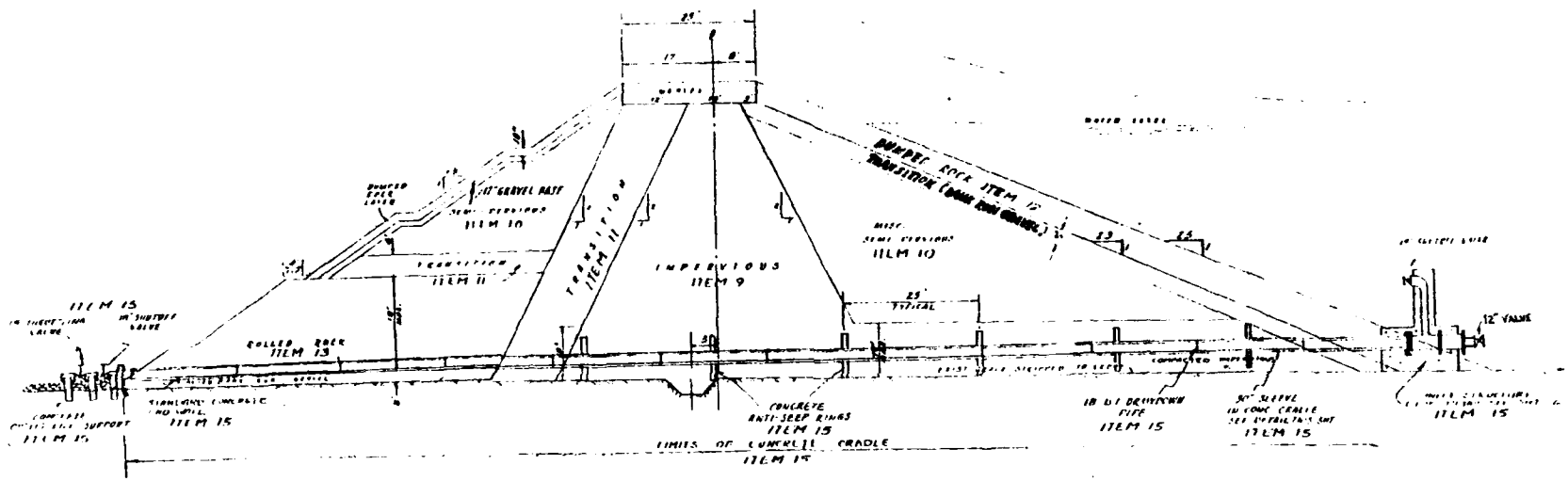
BORINGS AT PROPOSED DAM SITE



HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

ROARING BROOK DAM
BORING DATA



TYPICAL DAM SECTION

SCALE: 1" = 20'±

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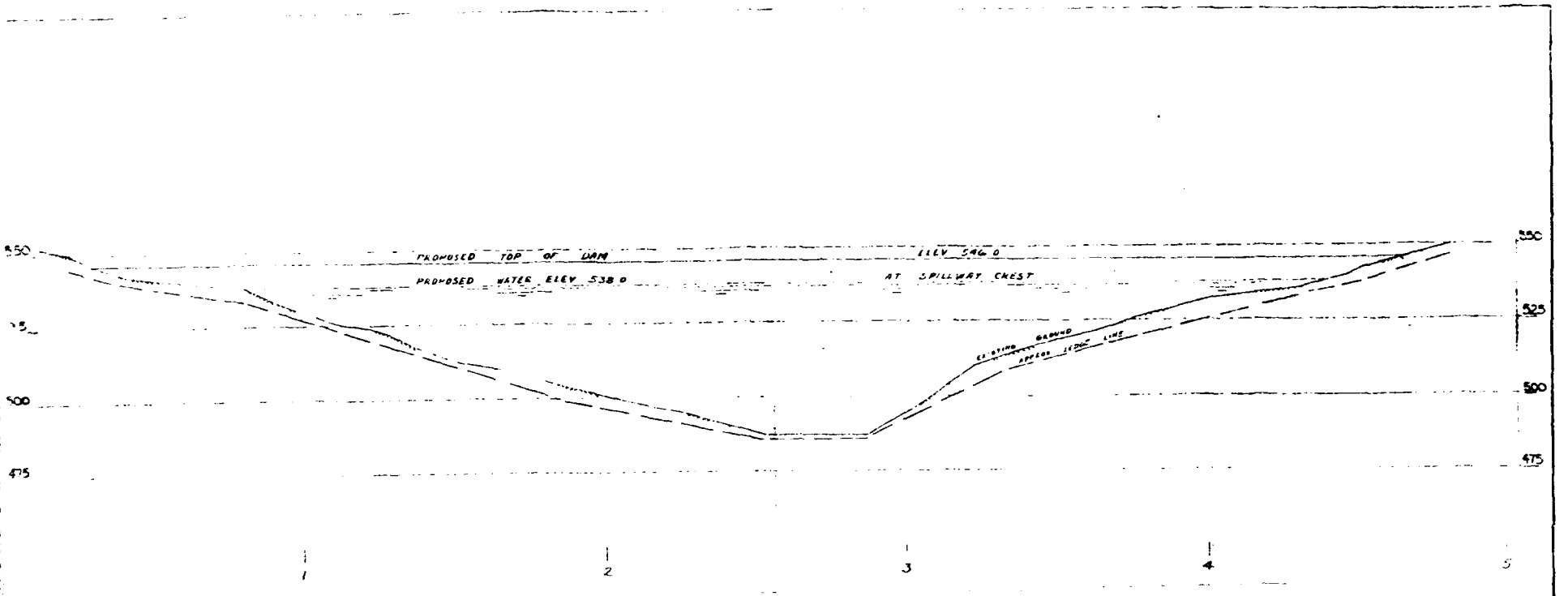
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

ROARING BROOK DAM
SECTION

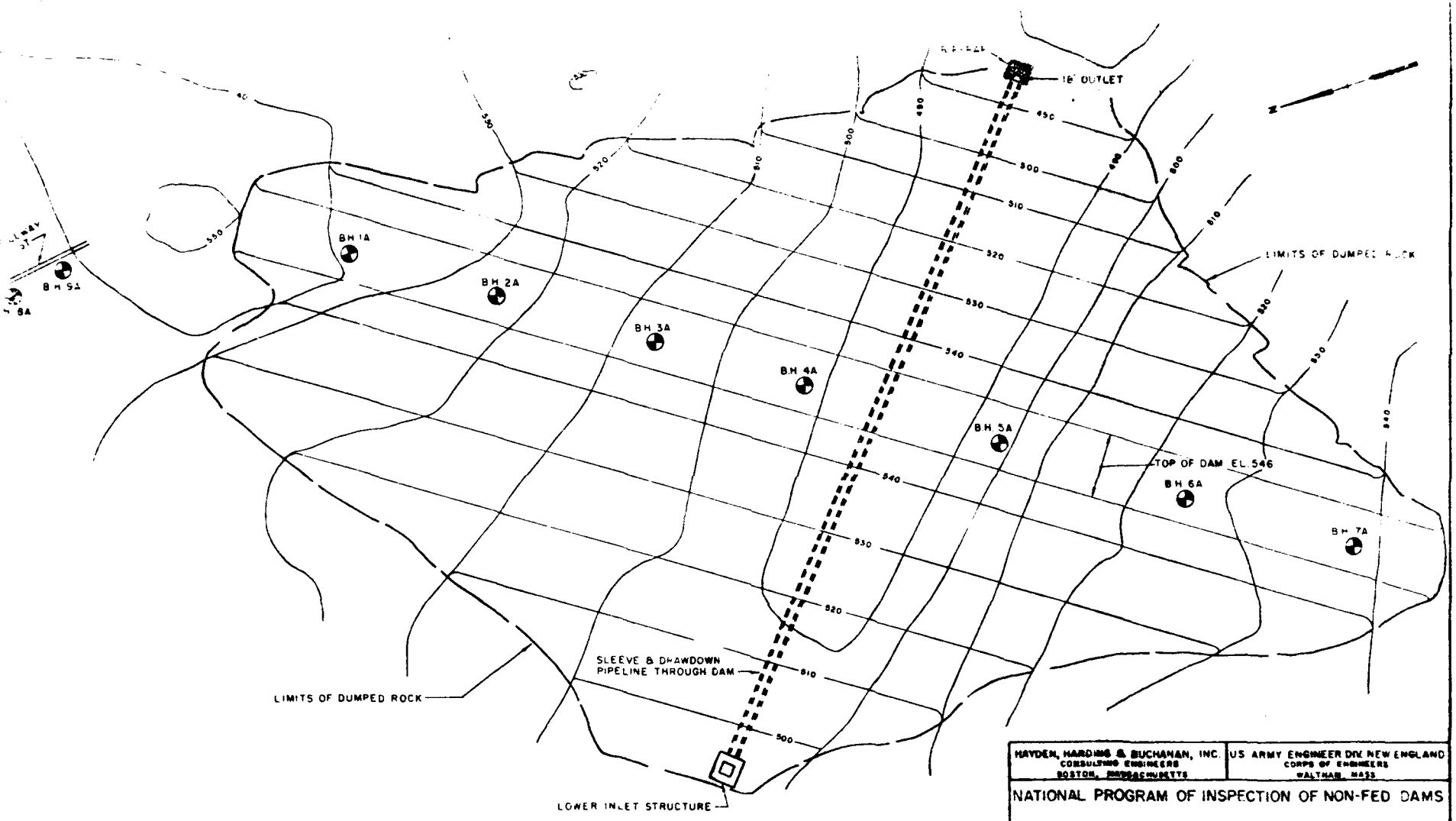


HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

ROARING BROOK DAM
PROFILE

MASSACHUSETTS



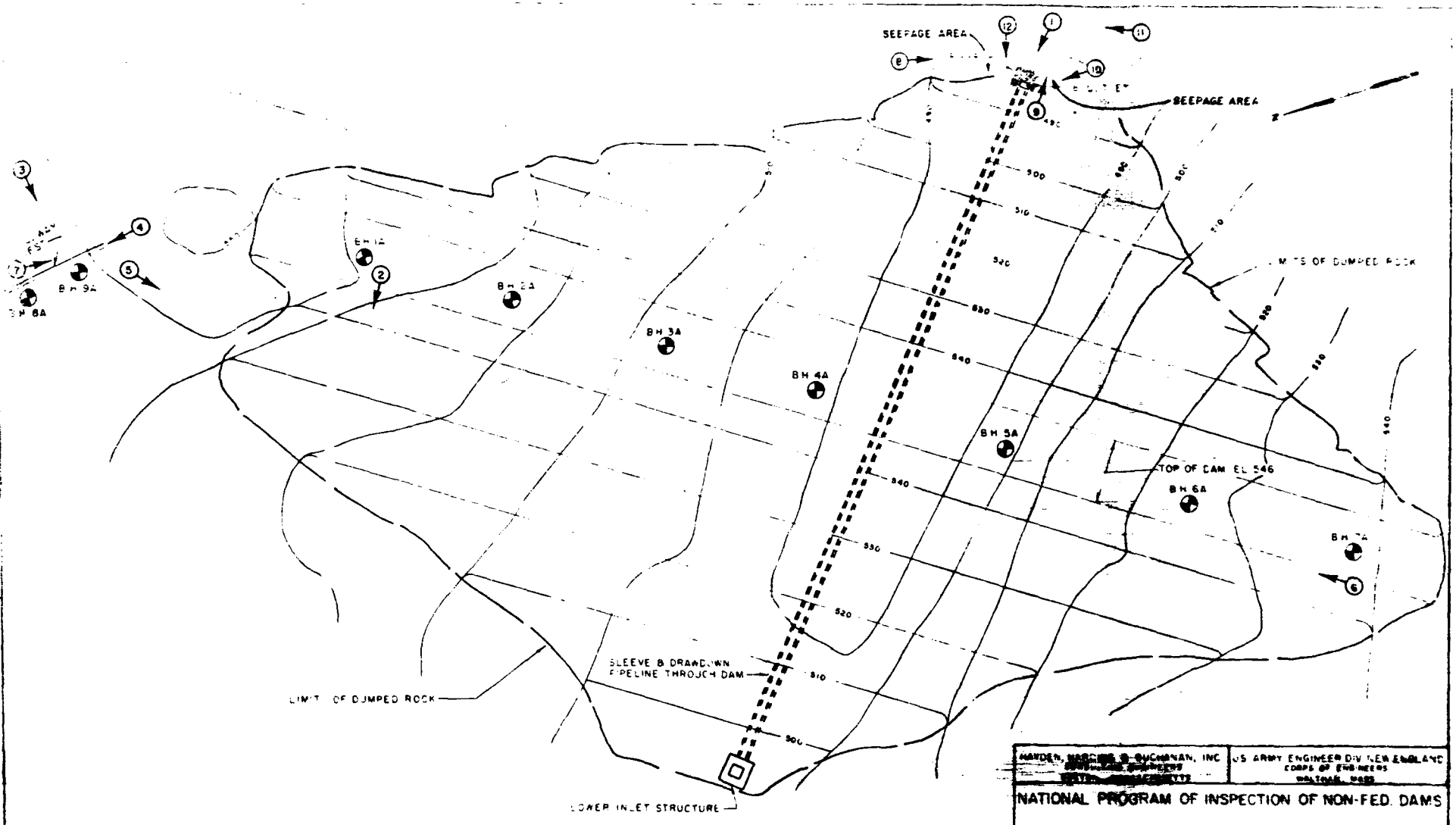
HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

ROARING BROOK DAM
PLAN

APPENDIX C

PHOTOGRAPHS



HAYDEN, MARCHES & BUCHANAN, INC

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

ROARING BROOK DAM
PHOTO LOCATIONS

LIST OF ENGINEERING DATA

Design plans prepared by Tighe & Bond dated 1972 were made available at the South Deefield Water Supply District Office, P.O. Box 51, South Deerfield, Massachusetts 01373.

Hydraulic calculations dated 1972 were provided by Tighe & Bond, 50 Payson Avenue, Easthampton, Massachusetts 01027.

No additional engineering data was located.

APPENDIX B

ENGINEERING DATA

PERIODIC INSPECTION CHECKLIST

PROJECT ROARING BROOK DAM DATE July 8, 1981

PROJECT FEATURE Service Bridge NAME K. Dalenberg, D. Vine

DISCIPLINE Geotechnical, Structural, Hydraulic NAME R. Cheney, M. Angieri

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	None at this project.
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Underside of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

PERIODIC INSPECTION CHECKLIST

PROJECT ROARING BROOK DAM DATE July 8, 1981

PROJECT FEATURE Spillway NAME K. Dalenberg, D. Vine

DISCIPLINE Geotechnical, Structural, Hydraulic NAME R. Cheney, M. Angieri

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Below water.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	None of significance.
Floor of Approach Channel	Below water.
b. Weir and Training Walls	
General Condition of Concrete	Good
Rust or Staining	None observed.
Spalling	None observed.
Any Visible Reinforcing	None observed.
Any Seepage or Efflorescence	None observed.
Drain Holes	None.
c. Discharge Channel	
General Condition	Bedrock channel - good condition.
Loose Rock Overhanging Channel	None observed.
Trees Overhanging Channel	Trees in channel at intersection with outlet channel.
Floor of Channel	Bedrock.
Other Obstructions	None.
Other Comments	

PERIODIC INSPECTION CHECKLIST

PROJECT ROARING BROOK DAM DATE July 8, 1981

PROJECT FEATURE Outlet Structure NAME K. Dalenberg, D. Vine

DISCIPLINE Geotechnical,Structural,Hydraulic NAME R. Cheney, M. Angieri

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Good
Rust or Staining	Minor at bolts.
Spalling	None observed.
Erosion or Cavitation	None observed.
Visible Reinforcing	None observed.
Any Seepage or Efflorescence	None observed.
Condition at Joints	Good
Drain holes	None.
Channel	Bedrock and stone channel.
Loose Rock or Trees Overhanging Channel	None, except trees at junction with spillway.
Condition of Discharge Channel	Good.

PERIODIC INSPECTION CHECKLIST

PROJECT ROARING BROOK DAM DATE July 8, 1981

PROJECT FEATURE Outlet Works NAME K. Dalenberg, D. Vine

DISCIPLINE Geotechnical,Structural,Hydraulic NAME R. Cheney, M. Angieri

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	There is none at this project.
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECKLIST

PROJECT ROARING BROOK DAM DATE July 8, 1981

PROJECT FEATURE Control Tower NAME K. Dalenberg, D. Vine

DISCIPLINE Geotechnical,Structural,Hydraulic NAME R. Cheney, M. Angieri

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	There is none at this project.
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	All gates are manual.
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECKLIST

PROJECT ROARING BROOK DAM DATE July 8, 1981

PROJECT FEATURE Intake NAME K. Dalenberg, D. Vine

DISCIPLINE Geotechnical, Structural, Hydraulic NAME R. Cheney, M. Angieri

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	Below water.
Bottom Conditions	Below water.
Rock Slides or Falls	Below water.
Log Boom	Below water.
Debris	Below Water.
Condition of Concrete Lining	Below water.
Drains or Weep Holes	Below water.
b. Intake Structure	
Condition of Concrete	Below water.
Stop Logs and Slots	Below water.

PHOTO NO. 1 - Downstream slope from outlet channel.

PHOTO NO. 2 - Reservoir viewed from dam crest.

PHOTO NO. 3 - Downstream face of spillway.

PHOTO NO. 4 - Crest of spillway.

PHOTO NO. 5 - Upstream slope from spillway.

PHOTO NO. 6 - Crest from right abutment.

PHOTO NO. 7 - Upstream slope of dam from left abutment.

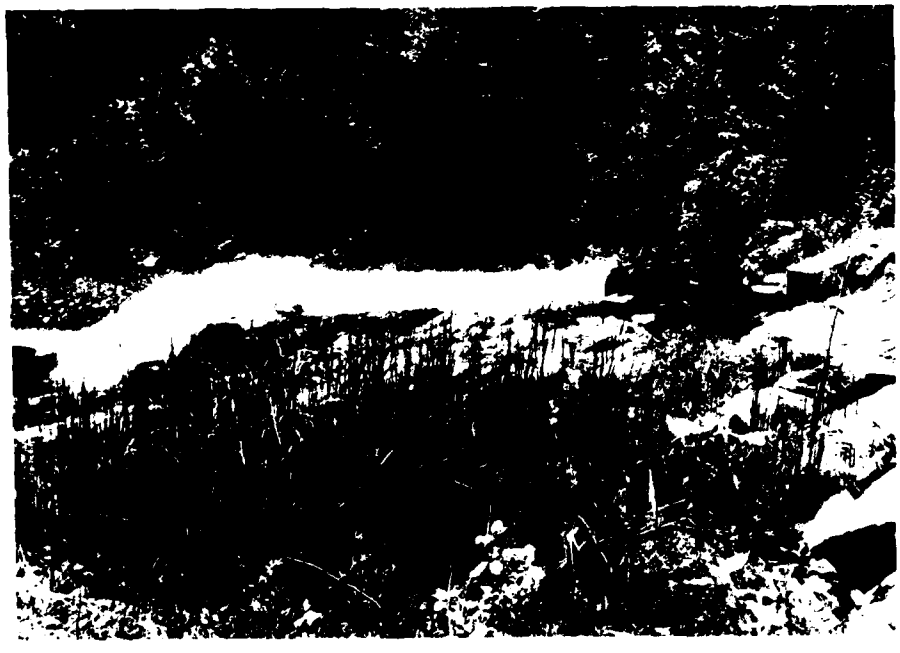


PHOTO NO. 8 - Dried swamp grass at downstream toe on left side of gated outlet structure.

PHOTO NO. 9 - Outlet structure discharge channel.

PHOTO NO. 10 - Seepage of about 2 GPM from toe of dam on right side of outlet pipe.

PHOTO NO. 11 - Trees at junction of spillway discharge channel with outlet channel in foreground.

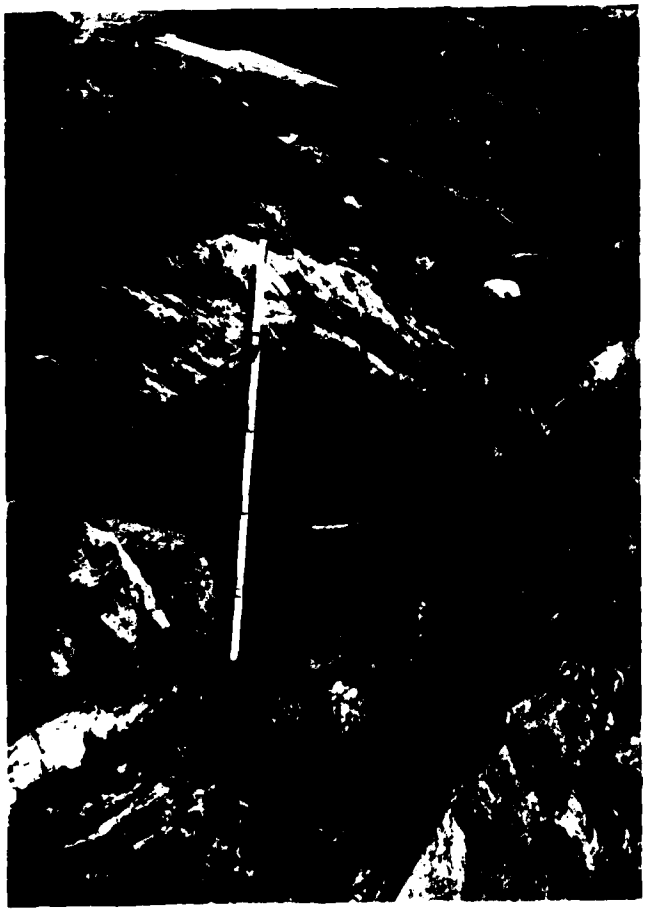


PHOTO NO. 12 - Seepage of about 1-2 gpm from toe of dam on left side of outlet pipe.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

B NO. 82061001
TE 8-5-81
MJA
D BY J. FERRISS

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D2
JOB Dams
SUBJECT Roaring Brook
CLIENT COE

Dam was built 1973-1974 by Roy M. Wright, Inc.

Dam was design by Tighe & Bond.

Constructed as earth embankment dam.

Hydraulic height = 65.± ft.

Storage Capacity = 440.± a-f to top of dam.

Size Classification: Intermediate

Hazard Potential = High - dry weather failure conditions

Drainage Area = 2,560. a or 4. s.m.

Test Flood Inflow = 8400. cfs from 4. s.m.

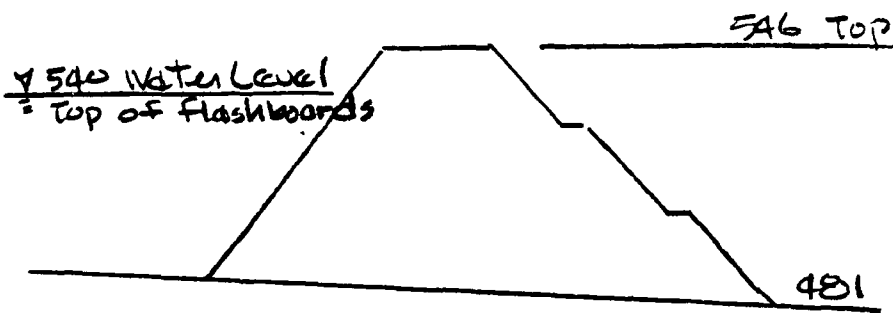
Routed Test flood Outflow :

a) without Flashboards = 8027 cfs at elev 546.4±
The dam is overtopped by 0.4 ft.
Spillway area can pass 7834. cfs
or 97% of routed outflow
at elev 546.4±.

b. With Flashboards = 8077. cfs, at elev 547 :
The dam is overtopped by 1.00 = foot.
Spillway area can pass 6926 cfs
or 86% of routed outflow
at elev. 547.

DAM FAILURE ANALYSIS

Dry weather conditions - NO spillway discharge



hydraulic height = 59 ft
length at mid height = 165 ft

$Q_F = {}^{8}/_{27} (0.4 \times 165) \times \sqrt{32.2} \times (59)^{1.5} = 50{,}300\pm$ cfs

At sta 70+00 Flood Stage is 11 ft, elev 213 for dry weather flow (no prior base flow flooding).

Damage to 5 homes & 3 barns due to dam failure only is 4 to 7 feet above First floor levels.

Dam has high hazard classification due to potential for loss of more than a few lives.

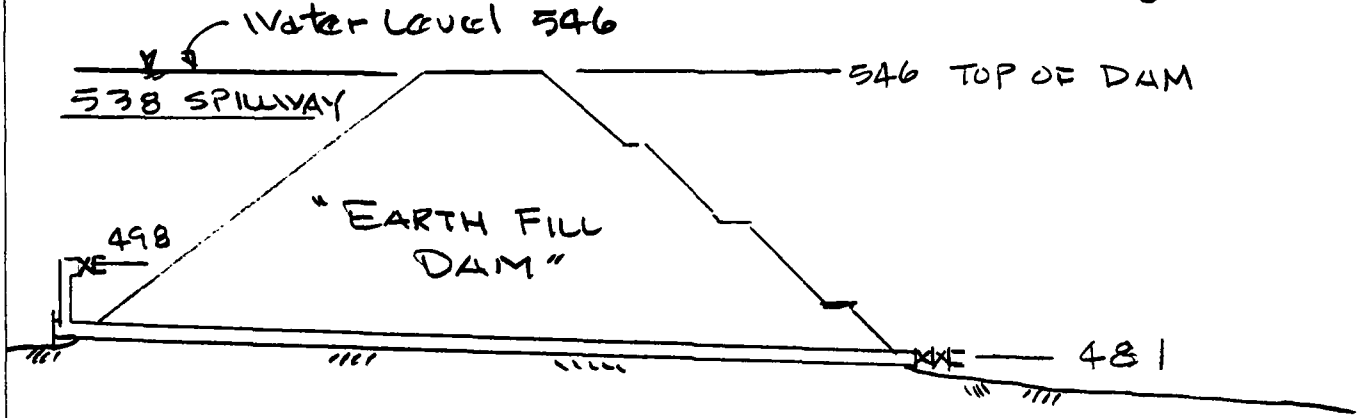
79206.1001
8-3-81
N/A
J. Ferriss

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D3A
JOB Dams
SUBJECT Roaring Brook
CLIENT COE

DAM FAILURE ANALYSIS

Wet Weather conditions - spillway discharge



hydraulic height = 65'
length at mid height = 190'

$$Q_F = \frac{8}{27} \times (0.4 \times 190) \times \sqrt{32.2} \times (65)^{1.5} = 66{,}963 \text{ cfs}$$

For wet weather dam failure conditions, dam is low hazard due to significant pre-failure flooding.

At sta 40+00± lower water supply dam could probably be destroyed.

At sta 70+00 to 80+00, at North street, there are at least 5 homes & 3 barns. Spillway discharge 7025± cfs flood depth is 8± ft. These homes could receive 1 to 3 ft of water inside first flr level.

Failure flood stage is 12.4 ft. These homes will recieve an additional 5 to 7 ft of flood water above the spillway flood stage.

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

TEST FLOOD ANALYSIS

SIZE CLASS hydraulic height = 65' Intermediate
Storage : 440 a-f small

"Intermediate"

Hazard Class "HIGH"

TEST FLOOD FROM CORPS GUIDELINES PMF

DRAINAGE AREA

2560 acres 4 s.m. mountainous/rolling

Inflow = 4 s.m. x 2100 = 8400. = PMF ✓

TEST FLOOD OUTFLOW

WITHOUT FLASHBOARDS

$Q_{P_1} = 8400$ $D_1 = 546.7$ $V_1 = 185$ a-f on 0.87 runoff

$Q_{P_2} = 8400\left(1 - \frac{0.87}{19}\right) = 8017$ ✓ $D_2 = 546.4$

$V_2 = 174$ on 0.81 $V_{ave} = \frac{.81 + .87}{2} = 0.84$

$Q_{P_3} = 8400\left(1 - \frac{0.84}{19}\right) = 8027$ ✓ CFS

ELEV = 546.4 ±

dam is overtopped by 0.4ft ±

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M/A
J. FERRISS

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D 5
JOB Dams
SUBJECT Roaring Brook
CLIENT COE

TEST FLOOD ANALYSIS - Continued

WITH FLASHBOARDS IN PLACE

Q_{P_1} = 8400 cfs D_1 = 547.05

V_1 = 155 a-f or 0.73"

$Q_{P_2} = 8400\left(1 - \frac{0.73}{19}\right)$ = 8077 cfs D_2 = 546.95

V_2 = 152 a-f or 0.71 V_a = 0.72"

$Q_{P_3} = 8400\left(1 - \frac{0.73}{19}\right)$ = 8077 D = 546.95

dam is over topped by 1± ft.

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)A
FERRISS

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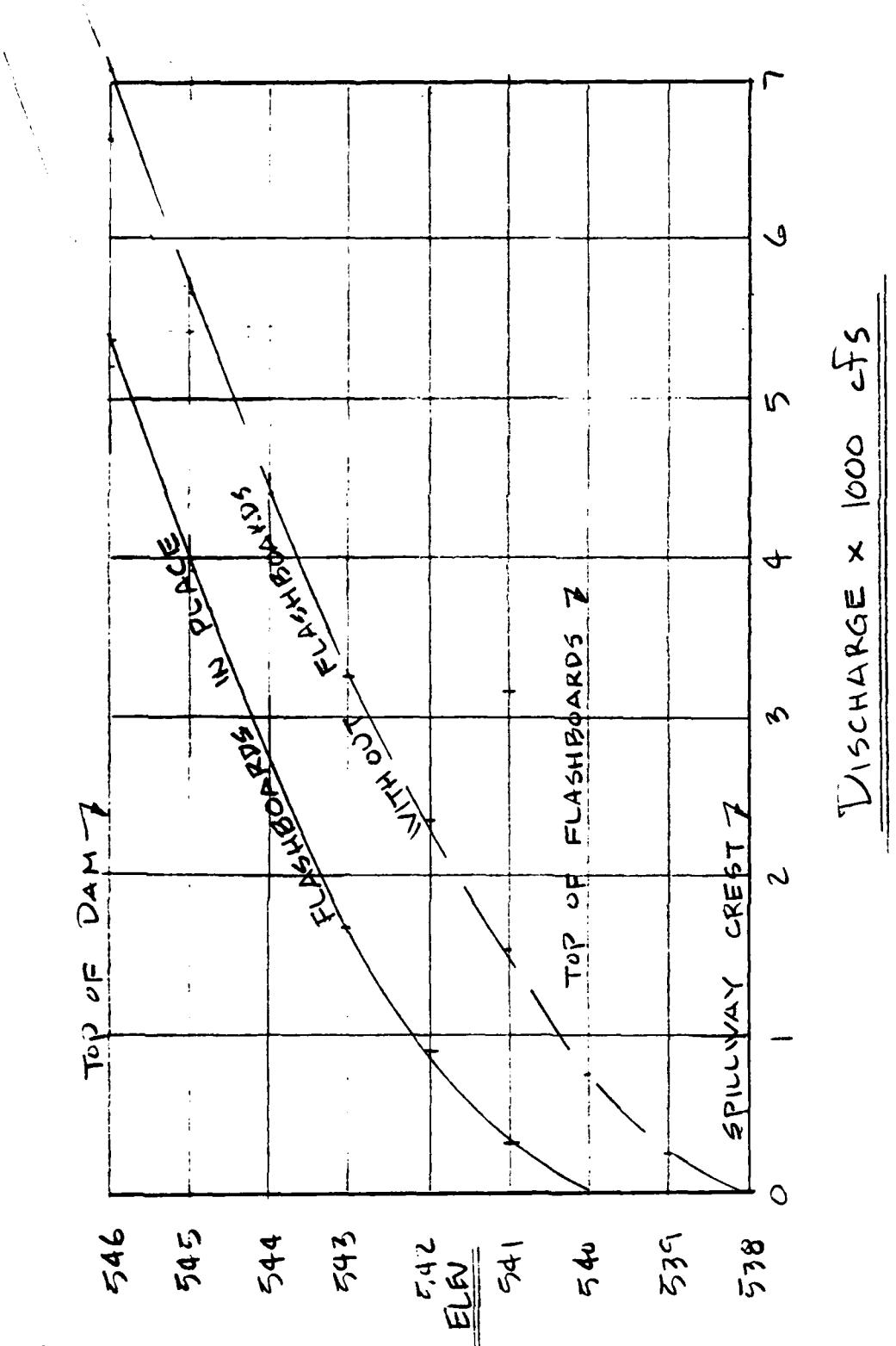
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D6
JOB Dams
SUBJECT Rodring Brk
CLIENT COE

SPILLWAY STAGE DISCHARGE



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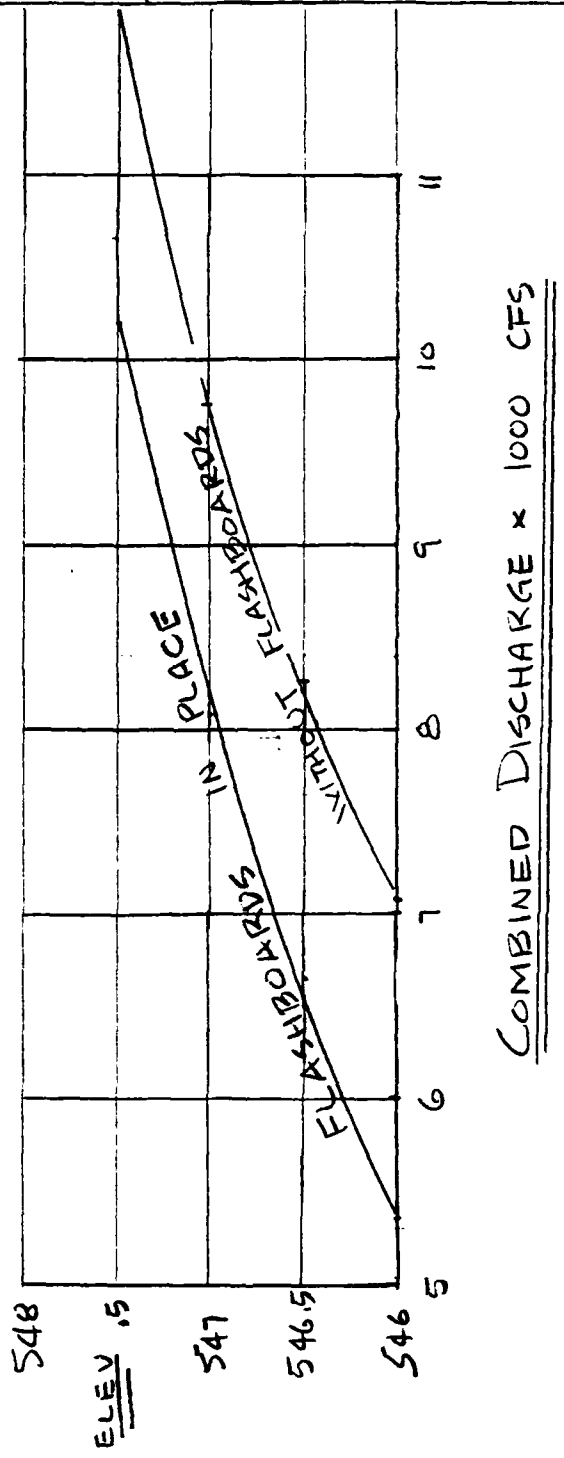
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

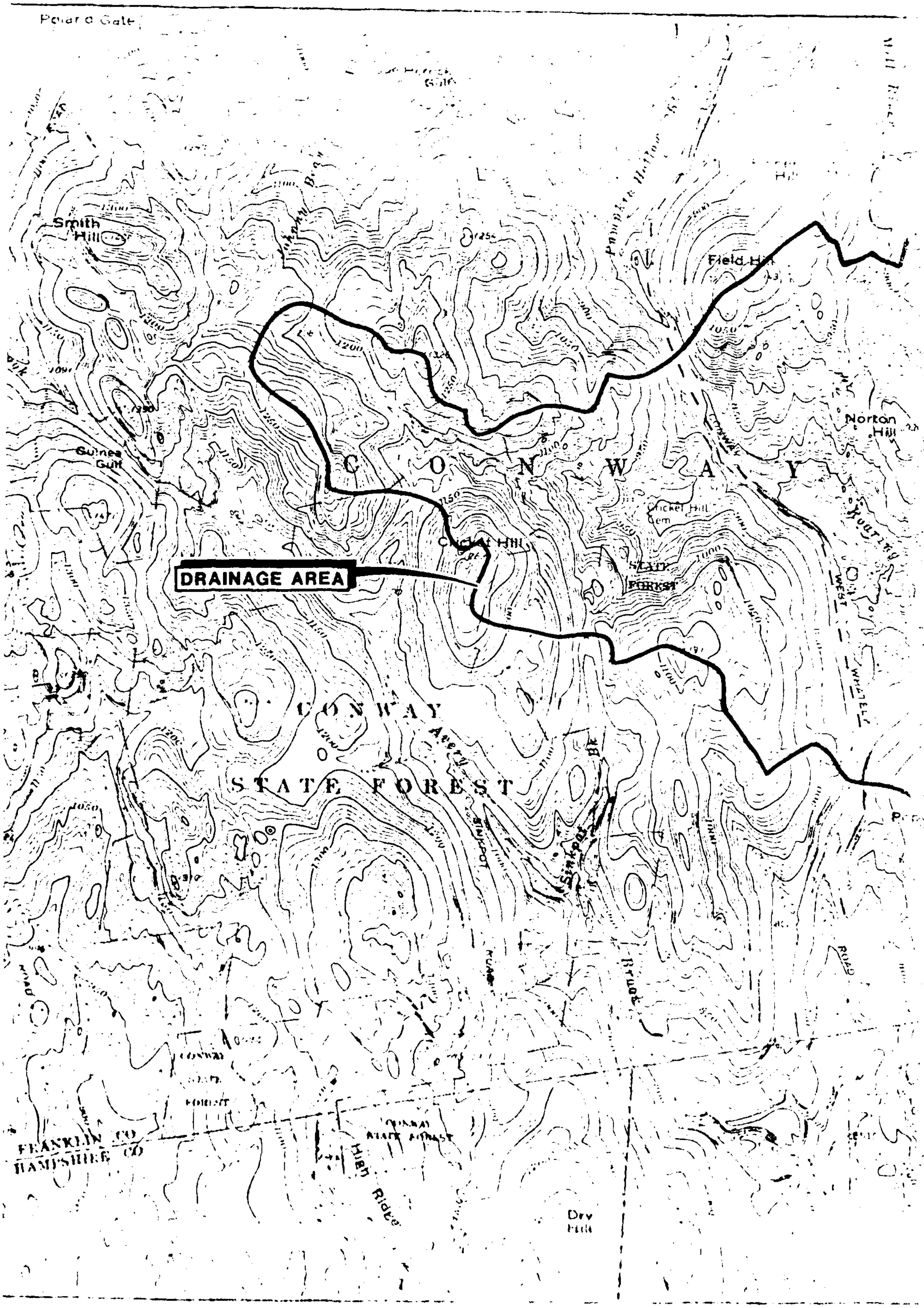
SHEET NO. D7
JOB Dams
SUBJECT Reading Brk
CLIENT COE

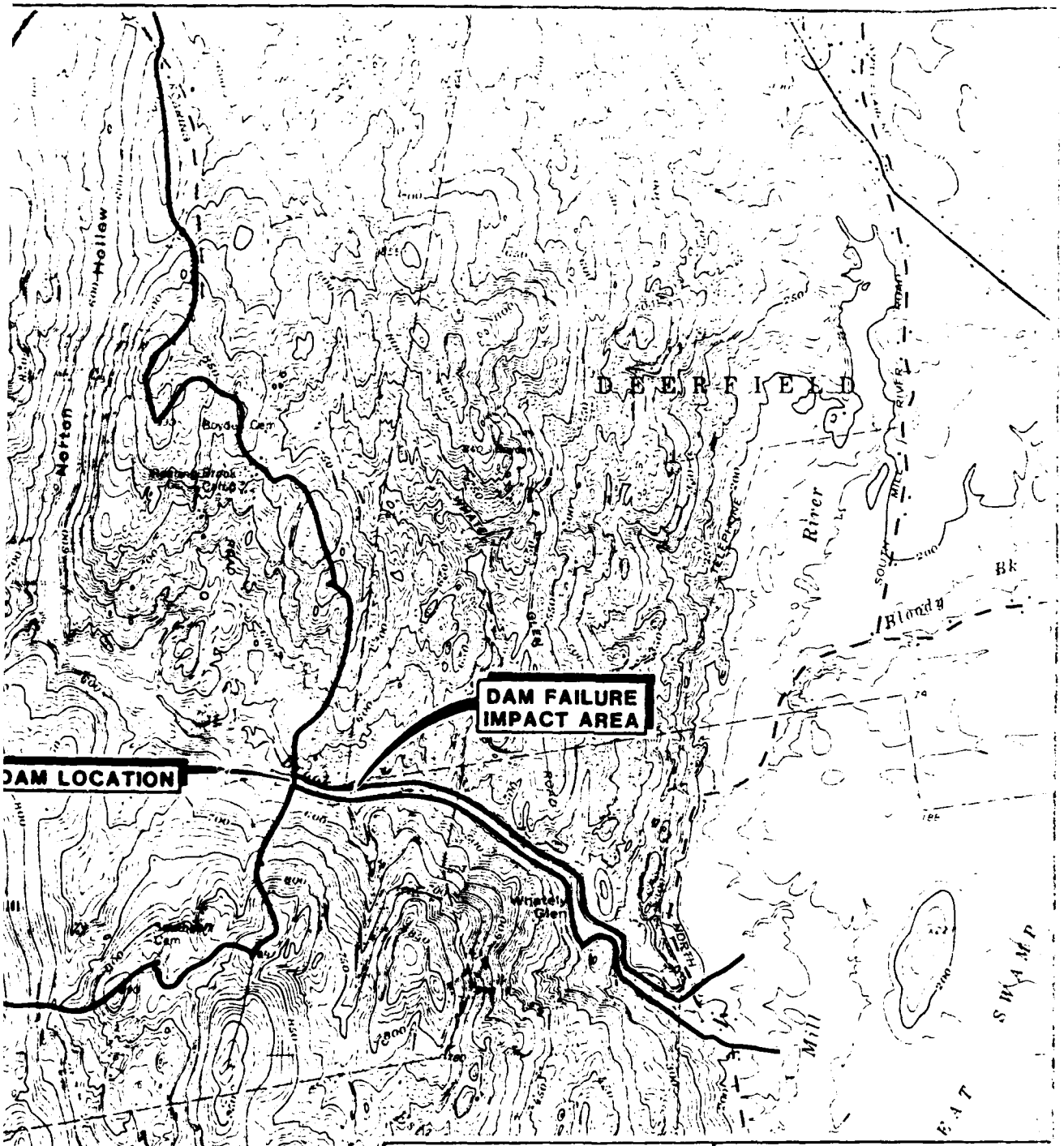
COMBINED DISCHARGE - SPILLWAY PLUS DAM OVERFLOW



APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS





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NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

ROARING BROOK DAM
DAM FAILURE IMPACT & DRAINAGE AREA

172

CONWAY MASSACHUSETTS

SCALE: 1:24000

DATE: AUGUST, 1981

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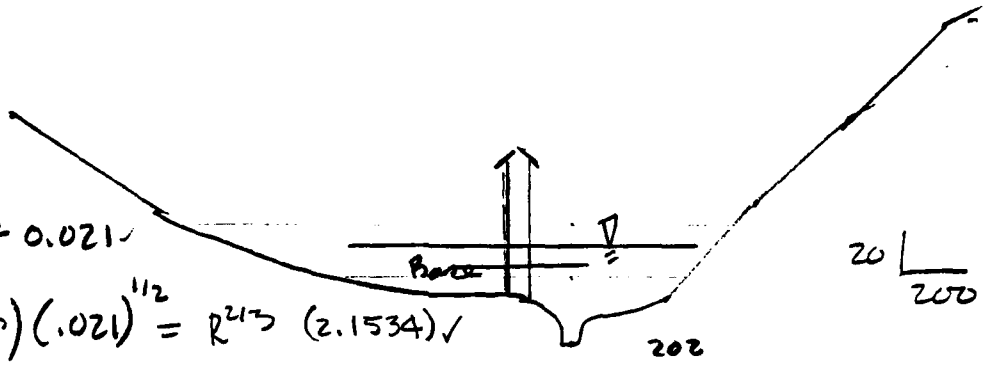
5-4-81
WA
J. Fecteau

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D 16
JOB Dams
SUBJECT Roaring Brk
CLIENT COE

Wet Weather

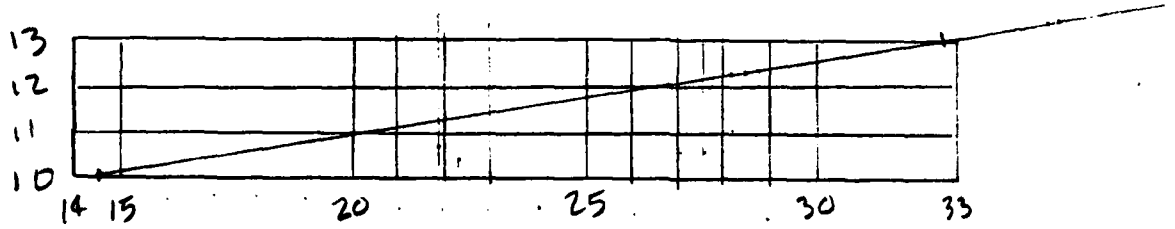
Sta 70+00



$S = \frac{42}{2000} = 0.021$ ✓

$V = \frac{1.486}{0.10}(R^{2/3})(.021)^{1/2} = R^{2/3}(2.1534)$ ✓

D	WP	A	$R^{2/3}$	2.1534 ✓	V	Q
5	140	280	1.59 ✓	"	3.4 ✓	959. ✓
7	360	880	1.82 ✓	"	3.92 ✓	3449. ✓
8	450	1285	2.02 ✓	"	4.35 ✓	5590. ✓
15	630	5360	4.2 ✓	"	9 ✓	48,450. ✓
10	470	2320	2.91 ✓	"	6.28 ✓	14560 ✓
13	600	4160	3.66 ✓	"	7.9 ✓	32783 ✓



$Q_{P_1} = 35171$ $D_1 = 13.4$ $V_1 = \frac{4400+1940}{2}\left(\frac{1500}{43560}\right) = 109$ ✓

$Q_{P_2} = 35171\left(1 - \frac{109}{553}\right) = 28{,}238$ $D_2 = 12.3$ ✓

$V_2 = \frac{3731+1940}{2}\left(\quad\right) = 98$ $V_a = 103.5$

$Q_{P_3} = 35171\left(1 - \frac{103.5}{553}\right) = 28{,}588$ $D = 12.3$

Elev = 214.3 ±

Base Flooding Elev = 211.0

19206.1001
3-9-81
WJG
J. FERRISS

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D15
JOB Dams
SUBJECT Roaring Brk
CLIENT COE

Wet Weather

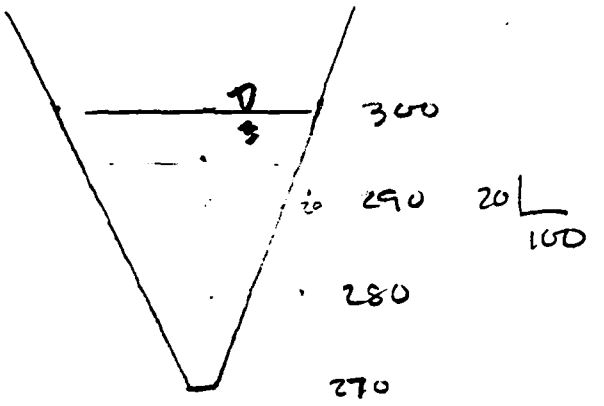
Sta 55+00

$S = \frac{80}{2000} = 0.04$

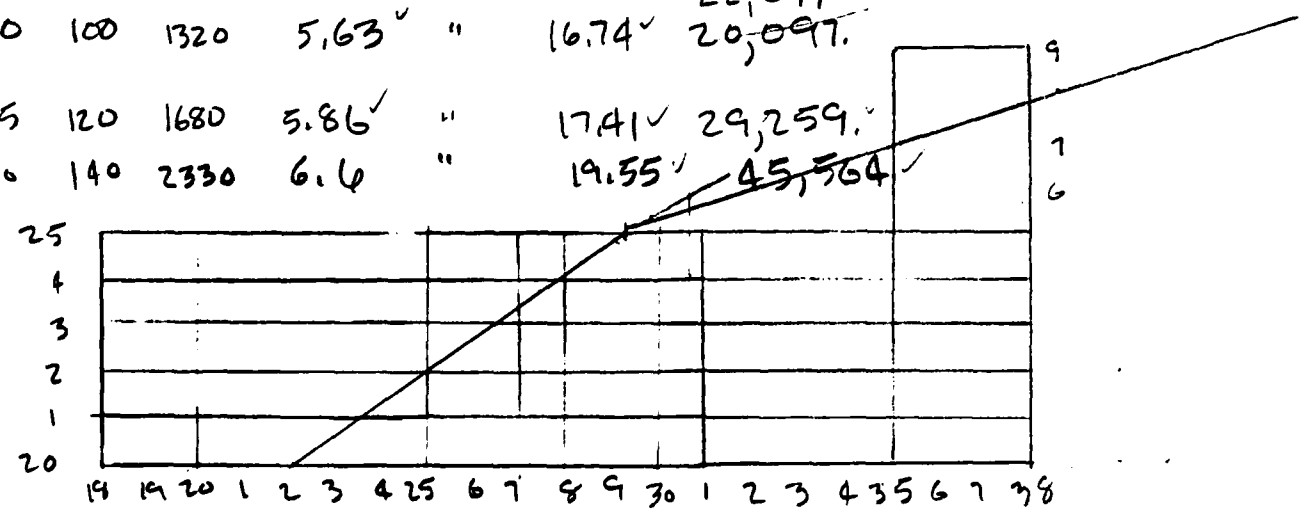
$n = 0.110$

$V = \frac{1.486}{0.10}(R^{2/3})(0.04)^{1/2}$

$V = R^{2/3}(2.972)$ ✓



D	WP	A	$R^{2/3}$	"2972" ✓	V	Q
20	100	1320	5.63 ✓	"	16.74 ✓	22,097 20,097.
25	120	1680	5.86 ✓	"	17.41 ✓	29,259. ✓
30	140	2330	6.6	"	19.55 ✓	45,564 ✓



$Q_{P_1} = 38821$ $D_1 = 28.1$ ✓ $V_1 = \frac{2083 + 2500}{2}\left(\frac{1000}{43560}\right) = 53$ ✓

$Q_{P_2} = 38821\left(1 - \frac{53}{553}\right) = 35100$ $D_2 = 27.0$

$V_2 = \frac{1940 + 2500}{2}(\quad) = 51$ $V_a = 52$ ✓

$Q_{P_3} = 38821\left(1 - \frac{52}{553}\right) = 35,171$ $D = 27$

Elev = 297.

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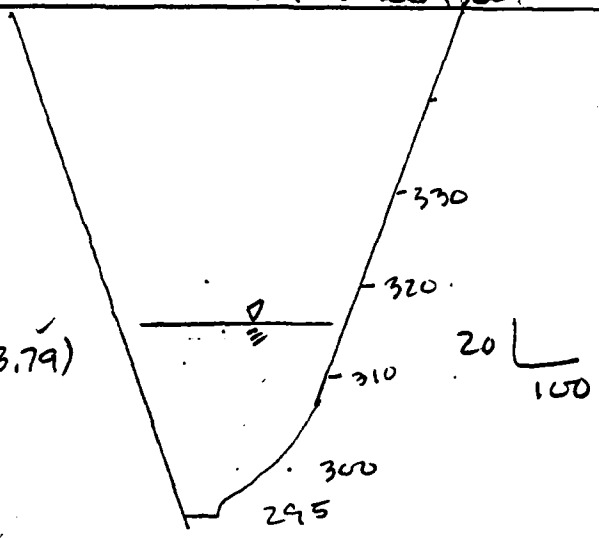
Wet Weather

Sta 45+00

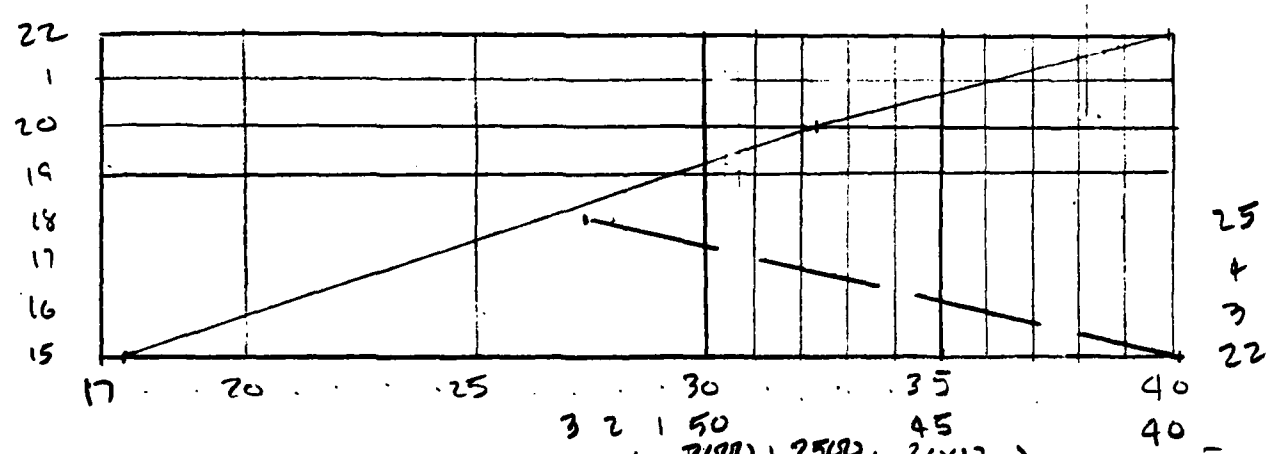
$S = \frac{130}{2000} = 0.065$ ✓

$n = 0.10$

$V = \frac{1.486}{0.10} R^{2/3} (.065)^{1/2} = R^{2/3} (3.79)$ ✓



D	WP	A	$R^{2/3}$	3.79	V	Q
25	135	2165	6.42 ✓	"	24.33 ✓	52666. ✓
20	120	1540	5.53 ✓	"	20.95 ✓	32,266. ✓
22	125	1780	5.93 ✓	"	22.46 ✓	39,986. ✓
15	100	990	4.65 ✓	"	17.6 ✓	17,432 ✓



$Q_{P_1} = 47391$ $D_1 = 23.7$ $V_1 = \frac{2000 + 2500}{2}\left(\frac{2000}{43560}\right) = 103$ ft/s ✓

$Q_{P_2} = 47391\left(1 - \frac{103}{553}\right) = 38,564$ $D_2 = 21.6$ ✓

$V_2 = \frac{1740 + 2500}{2}(\quad) = 97$ ✓ $V_a = 100$ ✓

$Q_{P_3} = 47391\left(1 - \frac{100}{553}\right) = 38,821.$ $D_3 = 21.7$ ✓

Elev = 316.7 ± ✓

NO. 7206.1021
8-3-81
MJA
BY J. FERRISS

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D13
JOB Dam
SUBJECT Roaring Fork
CLIENT COE

Wet Weather

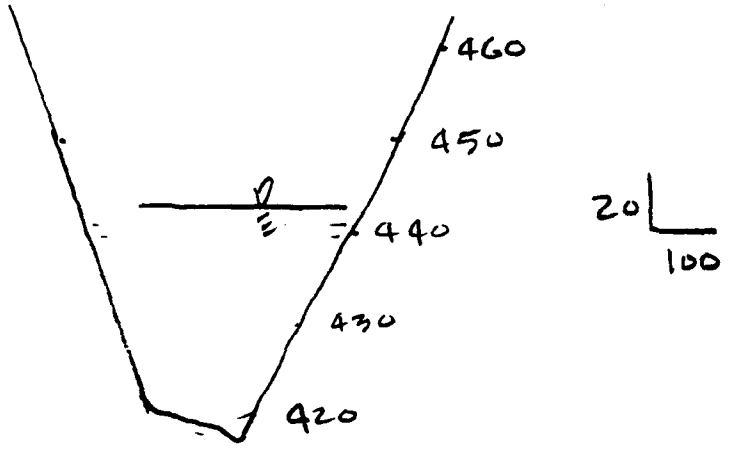
Sta 25+00

$S = \frac{100}{2500} = 0.04$

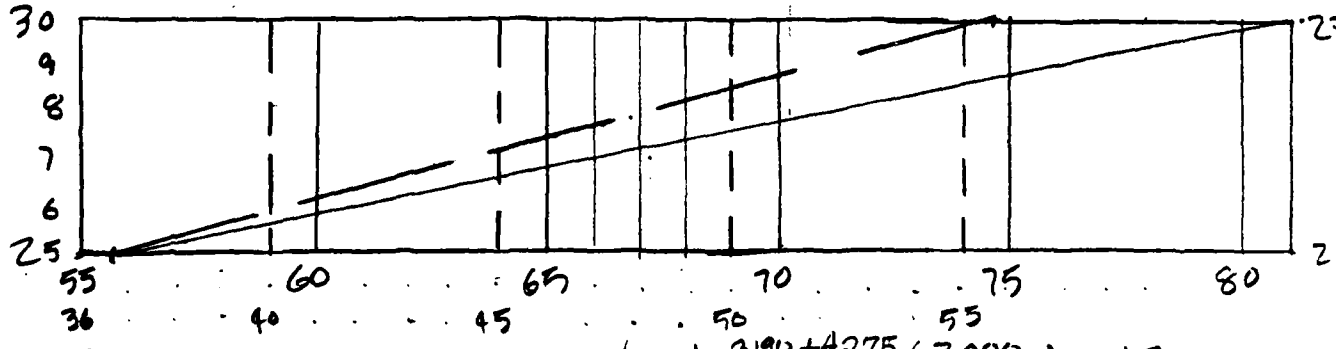
$n = 0.10$

$V = \frac{1.486}{.10}(R^{2/3})(.04)^{1/2} =$

$V = R^{2/3}\ 2.972$ ✓



D	WP	A	$R^{2/3}$	"	"	V	Q
20	145	2080	5.96 ✓	2.972		17.7 ✓	36,821. ± ✓
30	185	3680	7.41 ✓	"		22.04 ✓	81,100 ± ✓
25	165	2805	6.67 ✓	"		19.84 ✓	55,639. ± ✓



$Q_{P_1} = 67198$ $D_1 = 27.2$ ✓ $V = \frac{3190+4275}{2}\left(\frac{2000}{43560}\right) = 171$

$Q_{P_2} = 67198\left(1 - \frac{171}{553}\right) = 46,419$ $D_2 = 22.7$ $V_2 = \frac{2471+4275}{2}$ ( )

$V_2 = 163$ $= 155$

$Q_{P_3} = 67198\left(1 - \frac{163}{553}\right) = 47,391.$ $D_3 = 22.8$ ✓

Elev = 442.8 ✓

JOB NO. 79206.1001
DATE 8-3-81
BY MJA
CH'D BY J. FERRISS

HH&B HAYDEN, HARDING & BUCHANAN, INC.
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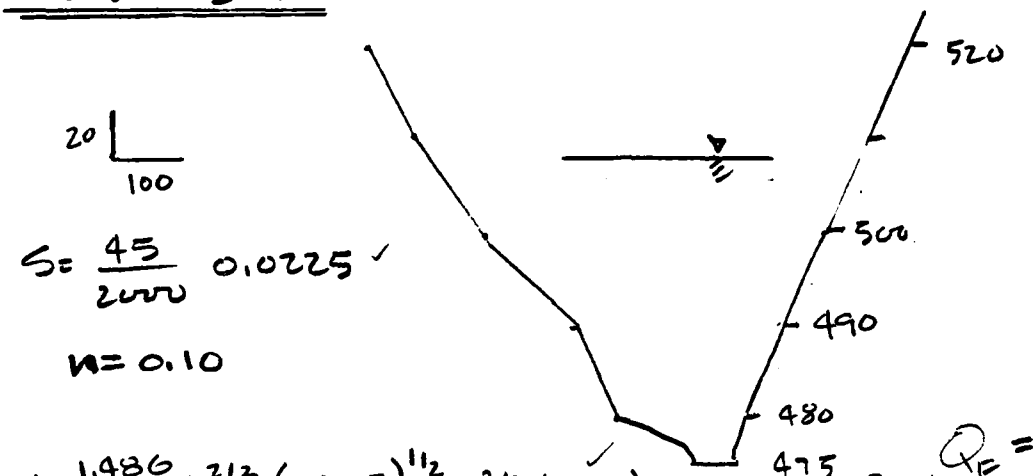
SHEET NO. D 12
JOB Dams
SUBJECT Reservoir Brk
CLIENT COE

Wet Weather

Std 5+00



$S = \frac{45}{2000} = 0.0225$ ✓

$n = 0.10$

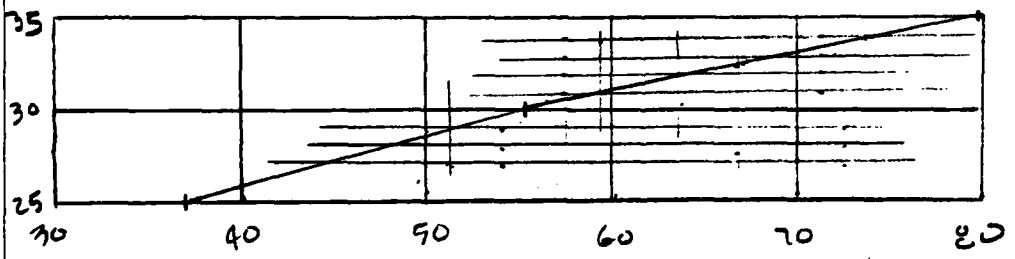
$V = \frac{1.486}{0.10} R^{2/3} (.0225)^{1/2} \cong R^{2/3} (2.23)$ ✓

Spillway Discharge = + 7025

$Q_F = 66963$ cfs

$Q_{F+S} \cong 74025.$ cfs

D	WP	A	$R^{2/3}$	2.23	V	Q
25	180	2700	6.14 ✓	"	13.7 ✓	36953. ✓
30	215	3700	6.73 ✓	"	15.0 ✓	55500. ✓
35	245	4850	7.39 ✓	"	16.5 ✓	79,938. ✓



$Q_{P_1} = 74025$ ✓ $D_1 = 32'$ ✓ $V_1 = \frac{4600 \text{ sF}}{1} \left(\frac{500}{93{,}560}\right) \cong 53$ ✓ a-f

$Q_{P_2} = 74025 \left(1 - \frac{53}{553}\right) = 66930.$ ✓ D_2 32.5

$V_2 = 4275 \left(\frac{500}{43560}\right) = 50^{\pm}$ $V_a = 51$

$Q_{P_3} = 74025 \left(1 - \frac{51}{553}\right) = 67{,}198$ ✓ cfs $D = 32.9$

Elev = 507.9

JOB NO. 79206.1001
DATE 9-4-81
BY MJA
CH'D BY

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D 11B
JOB Dams
SUBJECT Roaring Brk
CLIENT COE

Dry Weather Flow

Sta 45+00

$Q_{P_1} = 31,135$ cfs $D_1 = 19.6$

$V_1 = \frac{1850+1490}{2}\left(\frac{2000}{43560}\right) = 77$ a-F

$Q_{P_2} = 31135\left(1-\frac{77}{423}\right) = 25467.$ $D_2 = 17.6$

$V_2 = \frac{1850+1280}{2}(\ ) = 72$ $V_a = 75\pm$

$Q_{P_3} = 31135\left(1-\frac{75}{423}\right) = 25,615.$ $D_3 = 17.7$

Elev = 312.7

Sta 55+00

$Q_{P_1} = 25,615.$ $D_1 = 22.5$ $V_1 = \frac{1300+1500}{2}\left(\frac{1000}{43560}\right) = 32$

$Q_{P_2} = 25615\left(1-\frac{32}{423}\right) = 23,669.$ $D_2 = 21.2$

$V_2 = \frac{1300+1410}{2}(\ ) = 71$

$Q_{P_3} = 23700\pm$ $D = 21.2$ Elev = 291.2

Sta 70+00

$Q_{P_1} = 23700$ $D_1 = 11.5$ $V_1 = \frac{1410+3070}{2}\left(\frac{1500}{43560}\right) = 77$

$Q_{P_2} = 23700\left(1-\frac{77}{423}\right) = 19378$ $D_2 = 10.9$

$V_2 = \frac{1410+2120}{2}(\ ) = 71$ $V_a = 74$

$Q_{P_3} = 23700\left(1-\frac{74}{423}\right) = 19555.$ cfs $D = 11'$

Elev = 213

JOB NO. 79206.1001
DATE 9-4-81
BY MJA
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SHEET NO. C 11 F
JOB Dams
SUBJECT Roaring Fork
CLIENT COE

Dry Valley Failure Analysis

Sta 5+00

$Q_{P_1} = 50300$ cfs $D_1 = 29.5$

$V_1 = \frac{3600}{1}\left(\frac{500}{43560}\right) = 41.3$ a-f

$Q_{P_2} = 50300\left(1 - \frac{41.3}{423}\right) = 45386$ $D_2 = 27$

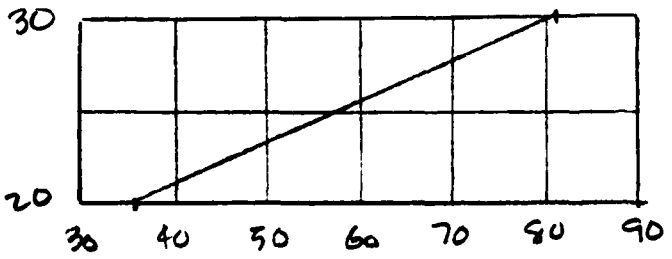
$V_2 = \frac{3100}{1}(\quad) = 35.6$ a-f $V_a = 38.4$

$Q_{P_3} = 50300\left(1 - \frac{38.4}{423}\right) = 45,729 \pm$ cfs

$D_3 = 27$ Elev = 502

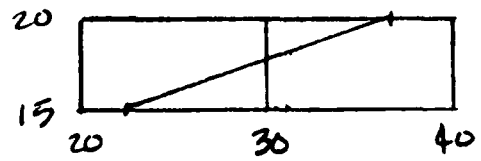
Sta 25+00

$Q_{P_1} = 45,729.$ $D_1 = 22.5$ $V_1 = \frac{3700+2480}{2}(\quad) = 142$



D	A	WP	$R^{2/3}$	V	Q
15	1430	120	5.26	15.6	22,357

$Q_{P_2} = 45729\left(1 - \frac{142}{423}\right) = 30,377.$ $D_2 = 18.$



$V_2 = \frac{3700+1820}{2}(\quad) = 127$

$V_a = \frac{127+142}{2} = 135$

$Q_{P_3} = 45729\left(1 - \frac{135}{423}\right) = 31,135.$ $D = 18.25$

Elev = 438.25

JOB NO. 79206001
DATE 8-4-81
BY M/A
CH'D BY J. FERRISS

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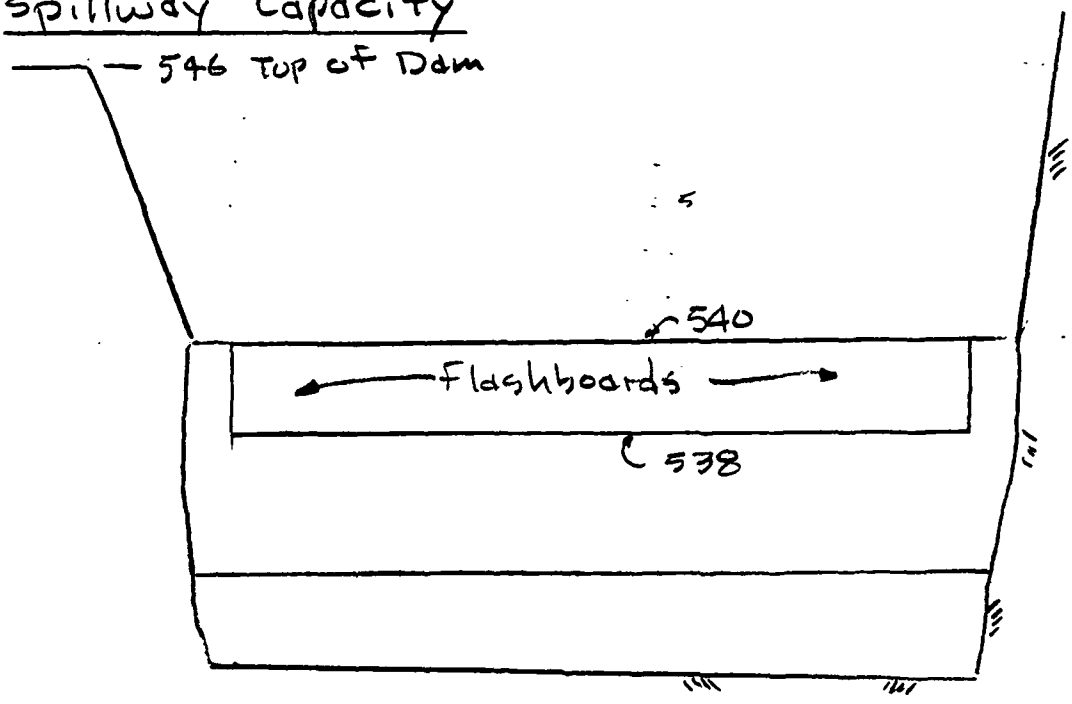
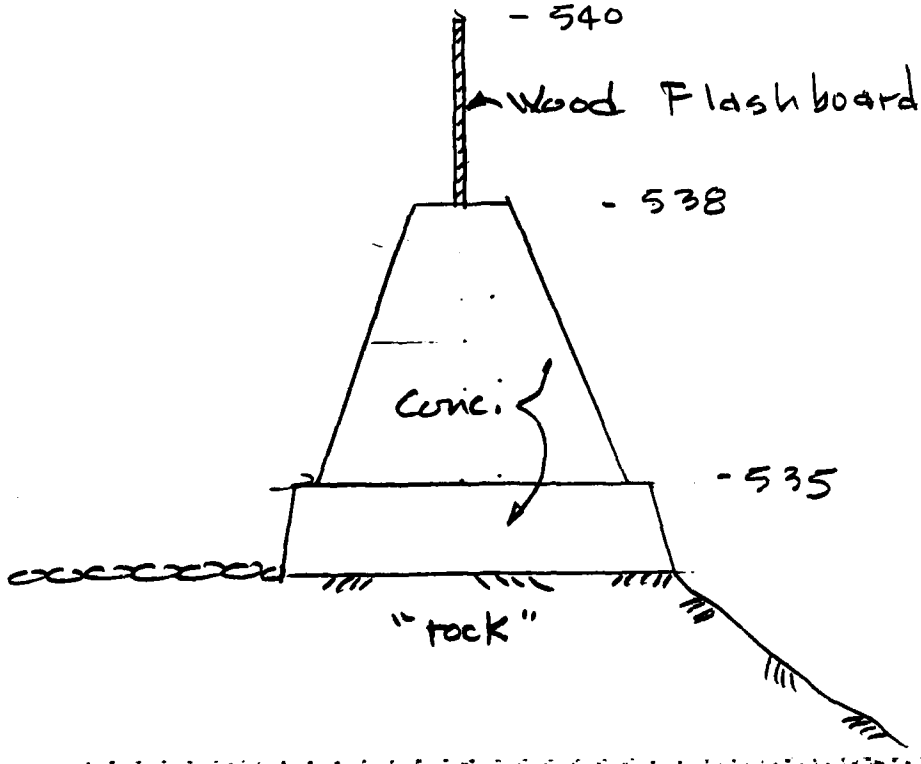
SHEET NO. D 11
JOB Dams
SUBJECT Roaring Brook
CLIENT CCE

Spillway Capacity





JOB NO. 7920G1001
DATE 8-3-81
BY MJA
CH'D BY J. FERRISS

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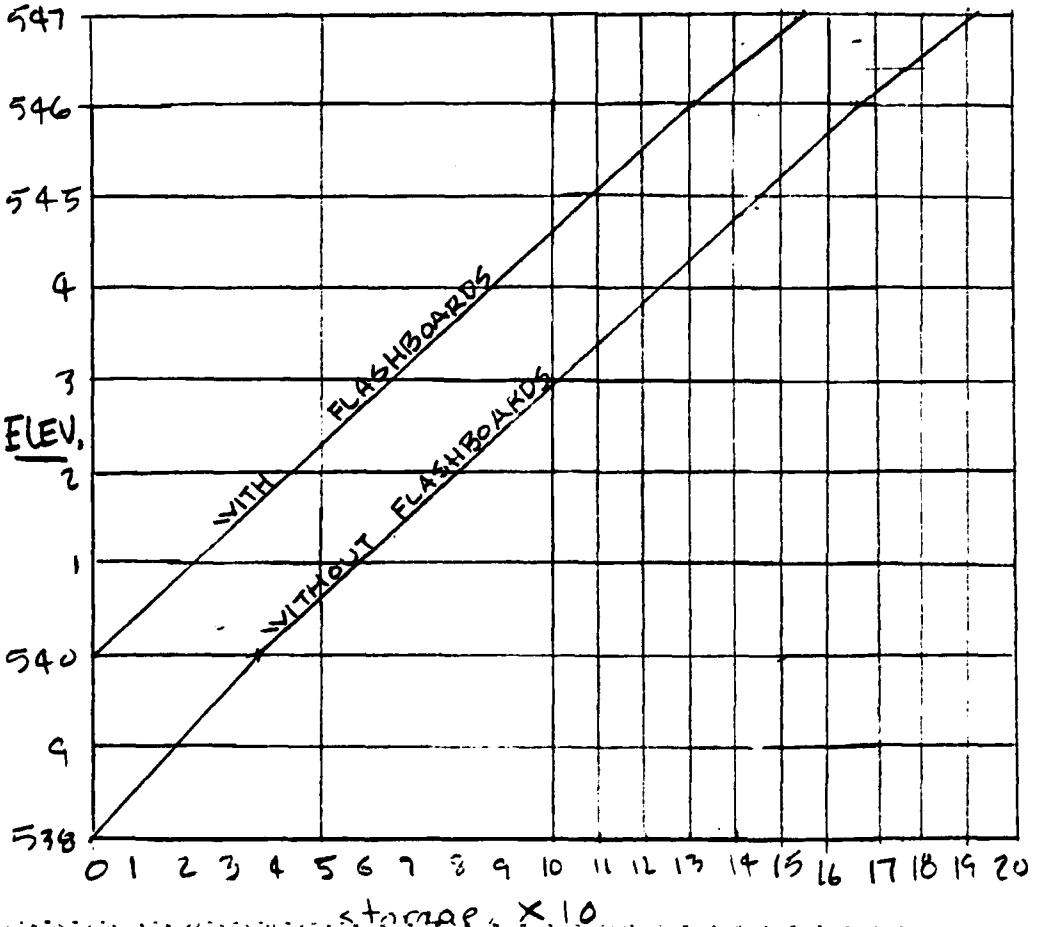
BOSTON — WEST HARTFORD

SHEET NO. D 10
JOB Dams
SUBJECT Roaring Brook
CLIENT COE

Storage Capacity

Elev	A	A_{ave}	D	V	V_T
	a	a	f	a-f	a-f
500	3 ✓	—	—	—	0
510	6.5	4.75 ✓	10 ✓	47.5 ✓	47.5 ✓
520	10.2	8.35 ✓	10 ✓	83.5 ✓	~~131.0~~ ✓
538	18.2	14.2 ✓	18	256	387 ✓
540	18.2	18.2 ✓	2	36.4 ✓	423. ✓
546	25.2	21.7 ✓	6	130.2	553 ✓
547	25.2 ✓	25.2 ✓	1 ✓	25.2 ✓	578 ✓



JOB NO. 79.206.1001
DATE 8-5-81
BY MJA
CH'D BY J. FERRISS

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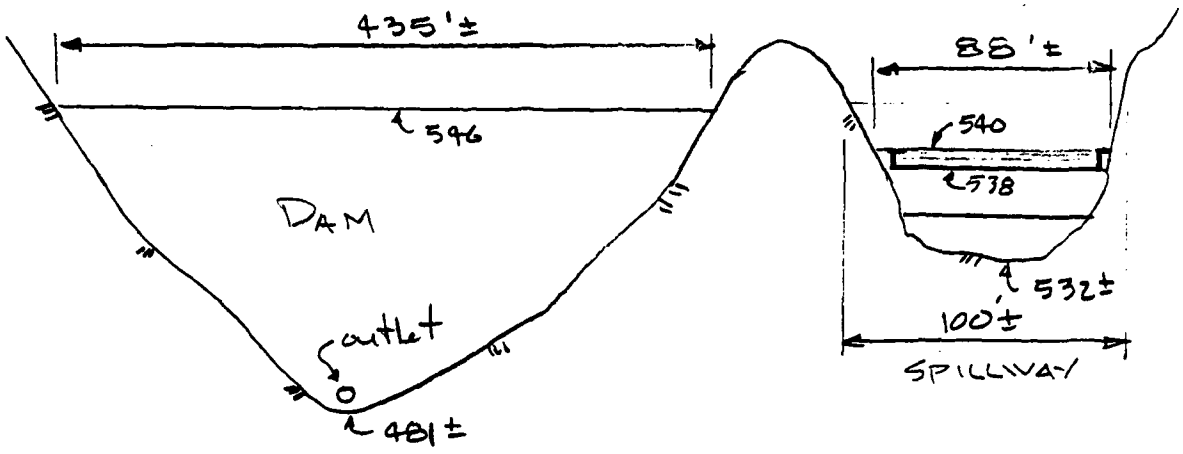
BOSTON — WEST HARTFORD

SHEET NO. D9
JOB Dams
SUBJECT Roaring Brk
CLIENT COE

Discharge - Dam Overflow



$Q = CLH^{3/2}$

D	$H^{3/2}$	C	L	Q_o cfs	ELEV	$Q_o + Q_{WOF}$ cfs	$Q_o + Q_{WF}$ cfs
0.5	0.35	2.7	435	415.✓	546.5	8,249.✓	6,665.✓
1.0	1.00	2.63	"	1157✓	547.0	9,762.✓	8,083.✓
1.5	1.837	2.63	"	2,150.✓	549.5	11,870.✓	10,202.✓
0.25	0.125	2.7	"	145✓	546.25		

JOB NO. 7912061001
DATE 8-4-81
BY MJA
CH'D BY J. FERRISS

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CONSULTING ENGINEERS
BOSTON — WEST HARTFORD

SHEET NO. D 8
JOB Dams
SUBJECT Roaring Brook
CLIENT

Spillway Capacity $Q = CLH^{3/2}$

with Flashboards in place.

D	L	$H^{3/2}$	C	Q_{WF} cfs	Elev
1	88	1	3.6	317 ✓	541 ✓
2	88	2.82	3.65	906 ✓	542 ✓
3	88	5.2	3.7	1693 ✓	543 ✓
4	90	8	3.75	2700 ✓	544 ✓
5	92	11.18	3.8	3908 ✓	545 ✓
6	94	14.7	3.88	5361 ✓	546 ✓
7	96	18.5	3.90	6926 ✓	547 ✓
7.5	100	20.54	3.92	8052 ✓	547.5 ✓

No Flashboards

D	L	$H^{3/2}$	C	Q_{WOF}	Elev
1	80	1	2.98	238 ✓	539 ✓
2	80	2.82	3.3	747 ✓	540 ✓
3	88	5.2	3.32	1518 ✓	541 ✓
4	88	8	3.32	2337 ✓	542 ✓
5	88	11.18	3.32	3266 ✓	543 ✓
6	90	14.7	3.32	4392 ✓	544 ✓
7	92	18.5	3.32	5650 ✓	545 ✓
8	94	22.63	3.32	7062 ✓	546 ✓
9	96	27	3.32	8605 ✓	547 ✓
9.5	100	29.28	3.32	9720 ✓	547.5 ✓

END

FILMED

8-85

DTIC